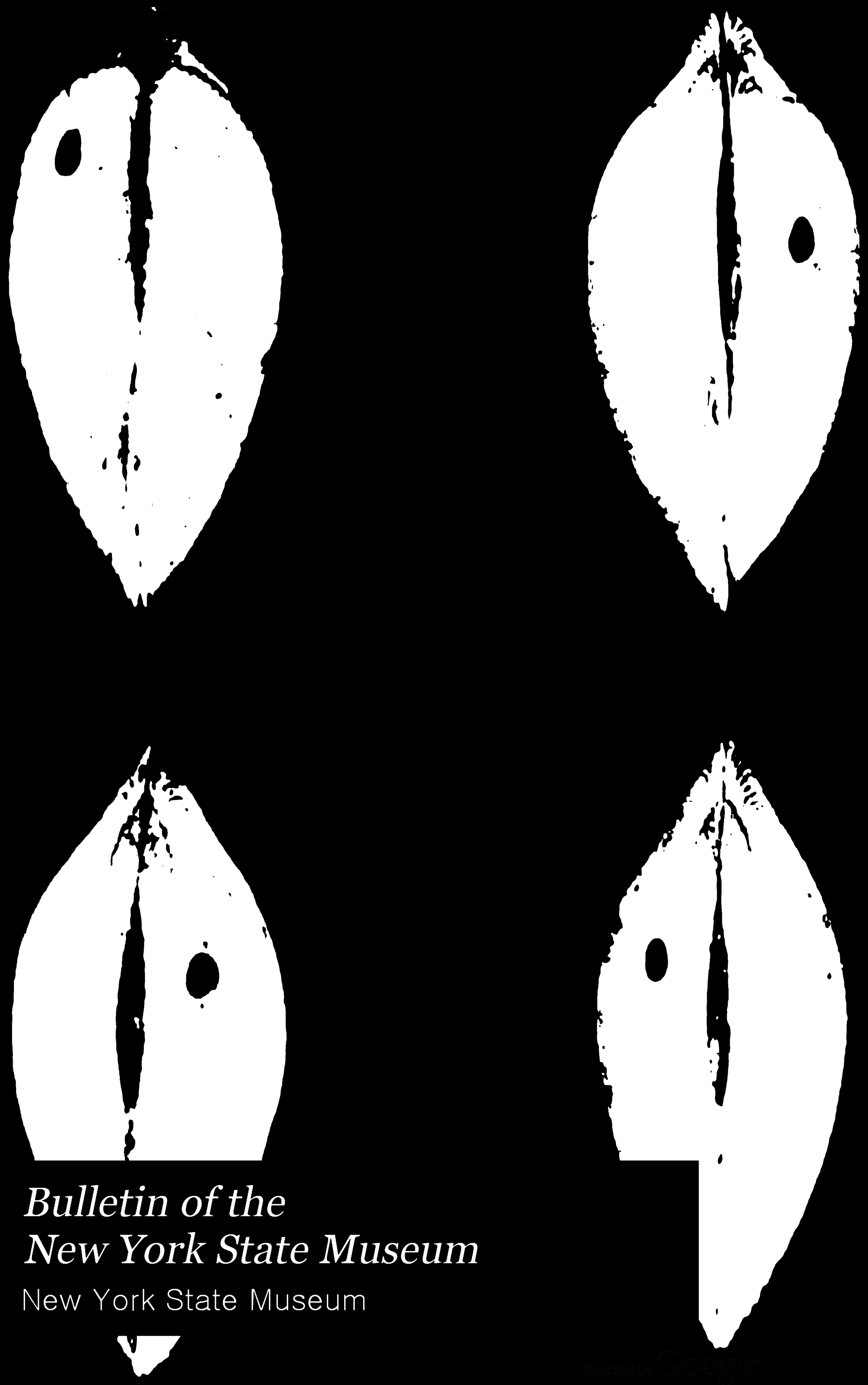

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Bulletin 70

MINERALOGY 3

LIST OF

NEW YORK MINERAL LOCALITIES

BY

H. P. WHITLOCK C. E.

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Bulletin 70

MINERALOGY 3

LIST OF

NEW YORK MINERAL LOCALITIES

PREFACE

The lack of systematic classification and of accurate geographic and geologic location of the many mineral localities of New York State, which so materially hampers a detailed study of any mineral collection, has suggested the preparation of a list of the recorded localities for mineral specimens in New York State, which is offered to the public in the following bulletin. The kindly reception accorded to the previous publications of this division of the New York State Museum has led to the hope that the present bulletin will meet a material want not only as a curatorial aid to museum workers in mineralogy in furthering a more accurate labeling of New York specimens but also as a guide to collectors, teachers and students in their field excursions.

The data have been largely compiled from the mineralogic and geologic publications given in the bibliography and have, in a number of cases, been added to, checked and modified by field notes and by the study of specimens from the collections mentioned in the list of authorities. Such a list must, from its character, be incomplete in many points and the author would gladly welcome any information which would render a subsequent edition more comprehensive and accurate.

The author is indebted to Dr F. J. H. Merrill, state geologist, for many valuable suggestions regarding the general character of the work and for much of the geographic and geologic informa-

tion embodied in the text. Acknowledgment is also tendered to the gentlemen whose names appear in the list of authorities for local information.

RELATIONS OF MINERAL DEPOSITS TO ROCKS

By far the greater part of the crystallized minerals of New York State occur in igneous and metamorphic rocks, or grouping these two divisions in a rather broader term, in crystalline rocks. The areas covered by these embrace two important sections of the State; the northern section including the Adirondack region and extending over St Lawrence, Jefferson and Lewis counties on the west and the southeastern section including New York, Westchester, Putnam and portions of Orange, Rockland, Richmond and Dutchess counties. The area of Silurian limestones, extending from west to east across the State just south of Lake Ontario and trending to the south along the west shore of the Hudson, affords many localites for secondary minerals notably calcite, dolomite, celestite, barite, quartz etc.

Igneous rocks

Granites and pegmatites. The component and accessory minerals of granite are commonly found in independent well formed individuals in cavities or vugs where the open space admits of free development of crystals formed by the separation of the mineral constituents from the fused rock magma in the process of its solidification. Pegmatite occurring in dikes and veins is characterized by the same genetic series of minerals found in granite but commonly in rather larger individuals corresponding to the coarser structure of the rock.

COMMON MINERALS FORMING AND OCCURRING IN GRANITE AND PEGMATITE

pyrite	**microcline**	epidote
marcasite	oligoclase	allanite
quartz	spodumene	tourmalin
corundum	**amphibole**	muscovite
chrysoberyl	beryl	**biotite**
rutile	garnet	titanite
orthoclase	zircon	xenotime
albite	topaz	apatite

Gabbros, diorites and other basic igneous rocks. Rocks of this series have for their chief feldspar constituents the plagioclases; both orthorhombic and monoclinic pyroxenes occur as component minerals. The formation of individual crystals takes place as the rock grades from finer to coarser structure and gives rise to strings or zones of crystallized minerals rather than pockets and cavities as is the case with granite.

COMMON MINERALS FOUND IN BASIC IGNEOUS ROCKS

magnetite	**labradorite**	garnet
ilmenite	**enstatite**	biotite
spinel	**hypersthene**	chrysolite
albite	**pyroxene**	titanite
anorthite		

Metamorphic rocks

Gneisses. Typical gneiss differs but little in mineralogic composition from typical granite. The mineral constituents are, however, to be found in larger and better formed individuals along zones of contact with crystalline limestone and local areas of magmatic segregation.

COMMON MINERALS FOUND IN GNEISS

graphite	hematite	sillimanite
chalcopyrite	**orthoclase**	cyanite
pyrite	albite	allanite
marcasite	**amphibole**	**tourmalin**
quartz	**pyroxene**	staurolite
corundum	**garnet**	muscovite
spinel	vesuvianite	**biotite**
magnetite	zircon	monazite
rutile	andalusite	apatite

Crystalline limestones. The crystalline limestones are prolific in accessory minerals which occur disseminated through the mass of the rock, in pockets or vugs or in zones of contact between the limestone and an adjacent igneous intrusive rock.

COMMON MINERALS FOUND IN CRYSTALLINE LIMESTONES

graphite	dolomite	garnet
sphalerite	siderite	titanite
pyrite	pyroxene	tourmalin
marcasite	wollastonite	chrysolite
quartz	amphibole	humite group
corundum	wernerite	muscovite
spinel	vesuvianite	phlogopite
rutile	zircon	clinochlore
brucite	danburite	talc
calcite	epidote	apatite

Crystalline schists. A characteristic series of minerals, for the most part silicates, is found in micaceous, hornblendic and argillaceous schists. They occur embedded and disseminated through the mass of the rock and reach their highest development along the contact portion of the rock mass.

COMMON MINERALS FOUND IN CRYSTALLINE SCHISTS

quartz	cyanite	biotite
chrysoberyl	andalusite	iolite
amphibole	sillimanite	tourmalin
garnet	staurolite	beryl
zircon	muscovite	

Serpentines and talc. The minerals occurring in serpentine are in some cases the unaltered species from which the serpentine was derived, in other cases secondary minerals resulting from a further alteration of the serpentine. They occur embedded and in veins of various thickness traversing the serpentine masses.

COMMON MINERALS FOUND IN SERPENTINE AND TALC

quartz (chalcedony)	magnesite	garnet
spinel	enstatite	clinochlore
chromite	pyroxene	talc
brucite	amphibole	deweylite
dolomite	chrysolite	apatite
calcite		

Secondary minerals

Secondary minerals, developed as a result of chemical action on previously formed rocks, are, to a large extent, deposited by percolating water. With regard to their mode of occurrence they may be classified as follows: (1) concretions; (2) deposits lining the interior of cavities, vugs, caverns and grottos; (3) vein formations; (4) minerals produced through pseudomorphism and paramorphism.

Concretions. Concretionary deposits of mineral matter are frequent in rocks of sedimentary origin. They are in general formed by the deposition, in successive layers around some organic center, of mineral matter leached from the surrounding rock. The calcium carbonate concretions found in clay beds are excellent types of this form of mineral occurrence. Concretionary forms of quartz, siderite, pyrite, chalcocite etc., are also formed in sedimentary rocks.

Deposits lining the interior of cavities, etc. The formation of secondary minerals in cavities of various origin results from the chemical action of percolating water on the rock adjacent to and forming the walls of the cavity. The soluble mineral matter is dissolved from the rock traversed by the descending surface water to be redeposited, sometimes in an entirely different form in the open spaces. The minerals thus deposited take the form of distinct crystallizations or of concentric, incrusting masses.

COMMON SECONDARY MINERALS OCCURRING IN CAVITIES

hematite	**barite**	apophyllite
limonite	**celestite**	stilbite
quartz	anhydrite	chabazite
calcite	**gypsum**	heulandite
dolomite	serpentine	harmotome
siderite	**sulfur**	analcite
aragonite	datolite	natrolite
strontianite	prehnite	

Vein formations.[1] Mineral veins may, with justice, be considered as constituting a division under the last named class of secondary mineral deposits; the distinctive character of the

[1]The formation of mineral veins has been very fully discussed by Posepny, F. Genesis of Ore Deposits. Am. Inst. Min. Eng. Trans. 1893. p. 23–197.

minerals found in veins has, however, led the author to consider them under a separate head. The large and important group of vein minerals includes most of the ores of commercial importance, particularly the metallic sulfids and sulfosalts.

VEIN MINERALS OF COMMON OCCURRENCE IN NEW YORK STATE

galena	fluorite	dolomite
sphalerite	quartz	siderite
millerite	cuprite	strontianite
pyrrhotite	hematite	orthoclase
chalcopyrite	magnetite	prochlorite
pyrite	rutile	barite
marcasite	brucite	celestite
arsenopyrite	calcite	gypsum

Minerals produced through pseudomorphism and paramorphism. Minerals included in this group are alteration products of primary minerals. These, while retaining the external form of the primary minerals, from which they were derived, differ essentially from them in composition.

Drift boulders

Transported masses of rock are found in all parts of New York State, frequently in boulders of considerable size. These are fragments of rock which, through action of glacial or fluvial erosion and transportation have been torn from their parent outcrops and have been carried, generally to the south and east of their original sources. The distance which the drift boulder may have been carried by the ice sheet in the glacial period varies widely so that no accurate estimate can be made of the distance between any glacial fragment and its parent mass.

SOURCES AVAILABLE FOR COLLECTING MINERAL SPECIMENS

The sources available for the collection of mineral specimens may be classified as follows:

- Sources
  - natural
    - surface outcrops
    - drift boulders
    - caves
  - artificial
    - mines and quarries
    - excavations for construction: foundations of buildings, sewers, subways
    - prospects

Surface outcrops. The surface outcrops of rocks of all formations but particularly unstratified rocks may be studied with considerable profit by the mineral collector in search of specimens. A judicious use of the hammer and cold chisel will often expose, under an unpromising cluster of weathered and decomposed crystals, fresh material well worth the labor expended on its development. The precipitous faces of cliffs and escarpments, furnish in some cases profitable sources for the collection of specimens.

Drift boulders and fragments. While in some instances drift boulders, notably those composed of crystalline rock, are valuable sources of mineral specimens the uncertainty regarding the original locality from which they were derived tends to render questionable the value of such specimens. A source of mineral material which may be classed under this head and which is often of more value than drift fragments embedded in the soil is the fragmental rock material used in the construction of stone walls. The accessibility of these to the roads and the comparative ease with which their component fragments may be identified with the country rock should not be overlooked by the collector particularly in a region of crystalline schists.

Natural caves. Subterranean tunnels and caverns, formed principally in limestones by the mechanical and chemical erosion of underground waters, frequently become repositories for secondary minerals deposited on the sides and roof as a result of the leaching action of percolating surface water. The exploration of these natural caves often results in the discovery of beautiful crystallizations which from the nature of their deposition are readily detachable.

Mines and quarries. Probably nowhere is the mineral collector better repaid for his trouble than in exploring the dump heap of a mine. The waste material representing, as most of it does, the contents of the contact zone between the vein or ore body and the country rock is usually rich in ore minerals as well as in crystallizations of accessory minerals from the country rock. Similarly but to a somewhat less extent the rejected material from a granite or limestone quarry is a profitable collecting source.

Excavations for building and improvements. From the casual manner in which these workings penetrate rock formations with respect to productive mineral zones they are hardly calculated to furnish the wealth of mineral specimens met with in mining and quarrying operations. It is, however, true that many rich finds such as, for example, the dumortierite of New York island have resulted from excavations for foundations of buildings, sewer diggings and other municipal improvement works. The accessibility of these excavations to the centers of population often results in a more careful study of the excavated material and in the finding of obscure mineral occurrences which might otherwise escape notice. Rocks exposed in railroad cuts and tunnels may also be said to constitute an important subclass under this head and possess the added advantage of being permanently available for collecting purposes.

Prospects. The use of rudimentary mining tools and methods is of considerable value in the acquiring of mineral specimens particularly in regions where mining and quarrying operations are not generally pursued. In most cases a knowledge of the prevailing dip and strike of the country rocks and of the location of the zones of contact between their strata will enable the collector to reach with the aid of a pick and shovel points where the component and accessory minerals occur in well crystallized aggregates. In some cases a blast exploded in a properly drilled hole will amply repay for the expense and trouble incurred, but of course such procedure should be attended with the greatest caution.

EXPLANATION OF LIST

In the following tabulated list of localities the first and fifth columns contain the numbers which have been assigned to each locality in order to furnish a ready and convenient means of reference. The second column gives with as much detail as is available the geographic position of the localities grouped under counties and towns. As far as possible definite geographic locations have been substituted for old names of farms, etc.; it has been the author's experience that it is at present extremely difficult to locate the original mineral locality by the old farm name. The third column gives a list of the mineral species

occurring at each locality. The fourth column contains descriptive notes regarding such crystallographic, structural, or other features as may be characteristic of the mineral occurrence. The sixth column is reserved for a quality mark which is assigned to certain occurrences to indicate the mineralogic quality or commercial importance of the material as follows:

xx indicates very fine specimens
x indicates fine specimens
* indicates that the mineral has been mined or quarried
† indicates that the mines or quarries are no longer operated

The absence of any of the above symbols in the sixth column opposite any given species indicates the occurrence of specimens of ordinary grade.

In the seventh column is noted the character of the rock in which the mineral species occurs, this in many cases being common to all the species found in any locality.

The eighth column contains a list of the mineral species associated with the mineral noted in the third column. This in many instances constitutes a genetic association which is of interest from the standpoint of the formation of minerals.

The numbers and letters given in the ninth column refer to the published and unpublished authorities as given in the following bibliography and list of unpublished authorities.

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j Mr W. W. Jefferies
k Prof. J. F. Kemp
l Mr H. O. Clough
m Dr F. J. H. Merrill
p Mr H. S. Peck
w The author

ALBANY

NO.	LOCALITY	SPECIES	DESCRIPTION
	Bethlehem		
1	Kenwood, north bank Normans kill	calcite	small nail head crystals
		quartz	small crystals
		pyrite	nodular concretions and crystals
2	1½m. n. w. Coeyman	epsomite	efflorescence on limestone
		calcite	stalactites and sinter
		gypsum	massive and snowy
3	Crystal hill, Glenmont	quartz	crystals
	Coeyman		
4	Coeyman	gypsum	selenite crystals
	New Scotland		
5	Indian Ladder	calcite	crystals
		pyrite	small crystals
6	1m. e. Indian Ladder	calcite	small brilliant crystals
		dolomite	white and pinkish aggregates
		aragonite	radiating needles
7	½m. s. of New Salem	pyrite	small bright crystals
	Watervliet		
8	Campbell	quartz	yellow drusy crystals

ALLEGANY

The Devonian shales and sandstones have been successfully drilled for petroleum in many in mineral localities.

BROOME

The Devonian shales, sandstones and conglomerates of this county do not include mineral

CATTARAUGUS

The Devonian shales and sandstones which constitute the rocks of this county have been otherwise these formations are unprolific in mineral localities.

CAYUGA

NO.	LOCALITY	SPECIES	DESCRIPTION
	Auburn		
9	at base of hill on e. bank Owasco creek	celestite	thin radial blades
		calcite	in minute crystals and rounded masses
		fluorite	
		epsomite	
	Springport		
10	Thompson's plaster beds	sulfur	semicrystalline
		gypsum	selenite

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
1	....	vein in shale	quartz....................	w
	....	"	calcite....................	w
	....	in shale........................	....	w
2	....	on limestone........................	....	5, 43
	....	in shale........................	gypsum....................	5, 43
	....	"	calcite....................	5, 43
3	....	"	....	5, 43
4	....	in clay........................	....	5, 43
5	....	in limestone........................	....	l
	....	"	....	l
6	....	"	dolomite, aragonite....................	l
	....	"	calcite....................	l
	....	"	"	l
7	....	in shale........................	....	w
8	....	"	....	5, 43

COUNTY

localities in the southern section of the county, otherwise these formations are not prolific

COUNTY

localities of sufficient importance to note in this list.

COUNTY

successfully drilled for petroleum in many localities in the southern section of the county,

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
9	....	in dark Salina limestone	calcite, fluorite etc.........	5, 43
	....	in slate........................	celestite	5, 43
	....	in Salina limestone..................	" calcite............	5, 43
	....	"	calcite, fluorite	5, 43
10	xx	in gypsum of Salina................	....	5, 43
	x.......	"	sulfur	43

CAYUGA

NO.	LOCALITY	SPECIES	DESCRIPTION
	Union Springs		
11		gypsum	selenite
		calcite	modified and twin crystals
		dolomite	curved crystals
		quartz	crystals

CHAUTAUQUA

The Devonian shales and sandstones which constitute the rocks of this county do not include

CHEMUNG

See Chautauqua

CHENANGO

See Chautauqua

CLINTON

NO.	LOCALITY	SPECIES	DESCRIPTION
	Ausable		
12	Arnold hill mines 1½m. w. Ferrona	magnetite	medium fine crystalline
		fluorite	purple and green
		pyrite	
		quartz	red jasper
13	Cook mine 1½m. e. Ferrona	magnetite	medium fine crystalline
		calcite	sharp needle crystals, radiating
		amphibole	crystals, dark green to black
		"	black fibrous hornblende
		oligoclase	in broadly striated cleavages
14	Winter mine 4½m. e. Ferrona	magnetite	
	Black Brook		
15	Palmer hill mines 1½m. n. Ausable Forks	magnetite	coarse grained
		orthoclase	flesh-colored
16	Tremblay's mine 1½m. w. Clayburg	magnetite	
17	Bowen & Signor's mine, Williamsb'g	"	
	Chazy		
18	Chazy	calcite	small nail head crystals
	Dannemora		
19	Dannemora	magnetite	
20	Chateaugay mines Lyon Mountain	"	coarse crystalline ore
		apatite	rounded grains
21	Lyon Mountain near Roger's field	pyroxene	long, well formed crystals with granular core

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
11	x	in Onondaga limestone	calcite, dolomite	43
	xx	"	dolomite	140
	xx	"	calcite	140
		"	"	140

COUNTY

mineral localities of sufficient importance to note in this list.

COUNTY

county.

COUNTY

county

COUNTY

12	x *	veins in gneiss	quartz, feldspars	149, 194
	x	"	" calcite	43
		"	"	*e*
		vein in gneiss	magnetite	*e*
13	*	veins in gneiss		*e*
		"		*e*
	x	"	magnetite, feldspar	*e*
		in gneiss	feldspar	*e*
	x	"	amphibole (hornblende)	*e*
14	* †	"		194
15	*	"	orthoclase	149, 194
		"	magnetite, quartz	149
16	* †			149, 194
17	*			149
18		fault plane in limestone		*h*
19	*			194
20	*	in granite	apatite, quartz etc	194
		" magnetite		*m*
21		" Bostonite dikes	plagioclase, olivin	159

COLUMBIA

NO.	LOCALITY	SPECIES	DESCRIPTION
	Ancram		
22	Ancram lead mines	galena	foliated and granular
		sphalerite	yellow and brown colors
		chalcopyrite	large masses with blue tarnish
		wulfenite	
		serpentine	
23	½ m. s.e. Ancram lead mines	albite	small transparent crystals
24	Morgan iron mine 2m. n. Ancram lead mines	limonite	loose decomposed ore cut by
		siderite	concretionary siderite
25	Reynolds mine ½m. e. Halstead	limonite	
		siderite	
	Austerlitz		
26		chalcocite	massive
	Canaan		
27		chalcopyrite	
		chalcocite	massive
	Copake		
28	Copake N. Y. & H. R. R.	limonite	large ore beds
		graphite	
	Hillsdale		
29	group of 3 mines, 3m. e. Hillsdale, 3m. n.e. Hillsdale, 1½ m.e.N. Hillsdale	limonite	
	Greenport		
30	near Hudson	gypsum	selenite
		wad	
		siderite	loose, decomposed material
		dolomite	grading into ankerite
		epsomite	efflorescences on slate
		calcite	small prismatic crystals
	Livingston		
31	Burden mines 2 m. s.e. Linlithgo	siderite	massive material altering to limonite
		quartz	small crystals
	Stuyvesant		
32	s. of Cary Brick Co., Coxsackie	gypsum	selenite crystals

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
22	*†	vein in talcose slate	sphalerite, chalcopyrite	5, 43
	*†	"	galena	5, 43
	*†	"	sphalerite, galena	5, 43
		"		5, 43
		"		*w*
23	x	in quartz vein	quartz	*w*
24	*†	" slate		149, 194
	*†	"		149, 194
25	*†			149, 194
				149, 194
26		in quartz vein traversing limestone		5
27		in veins of galena		43
		" "		5, 43
28	*	in slaty rock and limestone		43, 149, 194
				43
29	*†	in crystalline limestone		194
30	xx			43
	x			43
	x			43
				43
				5
		in Helderberg limestone		*w*
31	*†	in shale	quartz	194
		seams and pockets in iron ore	siderite	*w*
32	x	in clay bank		*w*

CORTLAND

The Devonian rocks of this county do not include mineral

DELAWARE

See Cortland

DUTCHESS

NO.	LOCALITY	SPECIES	DESCRIPTION
	Amenia		
33	Manhattan mine, Sharon Station Amenia mine, Amenia	limonite	
		turgite	
		siderite	
		chalcopyrite	
	Beekman		
33a	Sylvan Lake mines, near Sylvan Lake	limonite	
	Dover		
34	Dover Plains marble quarry	dolomite	massive
		amphibole	tremolite
35	Deuel Hollow mine 2m. s.e. South Dover	limonite	
36	Dover mine, Dover Furnace station	"	
		staurolite	small crystals
		garnet	small red and brown crystals
	East Fishkill		
37	Pecksville	graphite	foliated and granular
		talc	gray and white of uneven structure
		amphibole	pale green actinolite and hydrous anthrophyllite
		pyroxene	augite
38	Fishkill iron mines East Fishkill	limonite	
	Northeast		
39	near Smithfield	chalcocite	
		chalcopyrite	
		galena	
		sphalerite	
40	Riga Mine, Mount Riga	limonite	
40a	Malby mine, 1½ m. n.e. Millerton	"	

COUNTY

localities of sufficient importance to note in this list.

COUNTY

county.

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
33	x*†	in grayish blue limestone	siderite etc	149, 194
	x*†	"	limonite	43
	x*†	"	"	43
		"	"	5
33a	*†	"		149, 194
34		in crystalline limestone		5, 43
		"	dolomite	5, 43
35	x*†	"		149, 194
36		between strata of mica schist		149, 194
		in mica schist	garnet	5, 43
	x	"	staurolite	5, 43
37		in vein of granite		3
				5, 43
	x	in talc and limestone		5, 43
		" limestone	amphibole, dolomite	43
38	x*†	" schist		149, 194
39				5, 43
				43
				43
				43
40	*†	in limestone		149, 194
40a	*†	"		149, 194

DUTCHESS

NO.	LOCALITY	SPECIES	DESCRIPTION
	Pawling		
41	Pawling mine 2½m. w.n.w. of Pawling.	limonite......	....
	Poughkeepsie		
42	s. end of r.r. cut at Mine Point.......	anthracite.....	....
	Unionvale		
43	Clove mine.......................	limonite......	....
		gibbsite......	....

ERIE

The Devonian rocks in the vicinity of

ESSEX

NO.	LOCALITY	SPECIES	DESCRIPTION
	Chesterfield		
44	s.w. corner of town.................	magnetite......	titaniferous.................
	Crown Point		
45	iron mines, Hammondsville.........	magnetite......	medium fine crystalline..........
		pyroxene......	small black crystals.............
46	1 m. s. Hammondsville.............	apatite........	elongated terminated prisms......
		apatite........	mamillary eupyrchroite..........
		tourmalin......	fine brown crystals.............
		chlorite........	....
		quartz.........	crystals.......................
		calcite.........	....
		pyrite.........	crystals.......................
		garnet.........	brown crystals..................
		wernerite......	....
		oligoclase......	aventurin......................
		zircon.........	crystals.......................
		chalcopyrite....	....
		epidote........	small imperfect crystals ....
47	Skiff mine 2 m. s. Hammondsville. . .	magnetite.....	....
	Elizabethtown		
48	Gates mine 1m. s.e. New Russia.......	"	titaniferous ....
	Keene		
49	Weston mine 1m. s.w. Keene..........	"	....
50	2m. s.e. Keene.....................	pyroxene......	black crystals..................
51	Mount Marcy...................... *See also* locality 65.	"	dillage in foliated masses........

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
41	*†	in limestone		149, 194
42	*†	in green shale	quartz	*h*
43	*			43
				43

COUNTY

Buffalo furnish considerable natural gas.

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
44	*†	in norite		194
45	*	in gneiss	quartz, plagioclase	149, 194
		"	magnetite	159
46	x	in limestone	calcite	5, 43
	x*†	"	quartz	5, 43, 91
	xx	"	apatite, orthoclase	43
		"		43
		"		43
		"		43
	x	"		5, 43
	x	in gneiss, at contact		43
	x	"	orthoclase, magnetite	43
		"	quartz, "	5, 43
		"		43
		"	quartz	43
			" oligoclase	43
47				194
48	*†	in gabbro		149, 194
49	*†	in crystalline limestone	calcite, epidote	149, 194
50		"	wernerite	159
51		in gabbro		159

NO.	LOCALITY	SPECIES	DESCRIPTION
	Lewis		
52	Lewis Corners	wollastonite	abundant
		labradorite	dark gray, brilliant play of colors
		amphibole	actinolite, hornblende
		arsenopyrite	massive
53	Cross	wollastonite	abundant
		garnet	colophonite
	Minerva		
54	Minerva mine	magnetite	
	Moriah		
55	Sanford ore bed 6m. w. Port Henry	"	
		apatite	green and brown crystals
		allanite	large crystals
		lanthanite	in delicate scales
		amphibole	actinolite and hornblende
56	Mineville, Hall ore bed	magnetite	medium fine grained
		zircon	cinnamon red
57	Mineville, mine 21 etc	magnetite	in beautifully developed crystals
		zircon	large crystals
58	6m. n.w. P't H'n'y (Roe's spar bed)	tourmalin	in prisms sometimes altered internally
		muscovite	
		quartz	rose quartz
	Tredway quarry	serpentine	verd antique marble
59	Port Henry (Pease quarry etc.)	pyroxene	jet black massive and crystals
		"	white & pink diopsid in crystals
		pyrite	crystals
		pyrrhotite	strongly magnetic
		graphite	massive
		amphibole	hornblende
		wollastonite	crystalline
		orthoclase	adularia sometimes in minute transparent crystals
		titanite	yellowish brown
		tourmalin	brown

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
52	....	in gabbro	garnet, quartz etc..........	5, 43
	x.......	"	....	5
	....	"	....	5, 43
	....	"	hornblende................	5, 43
53	....	"	amphibole, garnet..........	5, 43
	....	"	....	5, 43
54	*†.....	....	....	194
55	*†.....	in gneiss........................	apatite, amphibole..........	5, 43, 149, 175, 194
	....	"	....	5, 43
	xx......	"	magnetite, apatite..........	12, 39, 162
	....	in fissures in the ore and on allanite.....	magnetite, allanite	12, 43
		....	magnetite, allanite..........	5, 43
56	x*......	in gneiss........................	zircon....................	43, 194
	x.......	" quartz vein....................	magnetite................	5, 43
57	xx*.....	" gneiss........................	apatite..................	43, 194
	x.......	" quartz........................	magnetite................	43
58	x.......	" granular limestone................	....	5, 43, 98, 221
	......	"	....	5
	x.......	"	....	5, 43, 98
	x.......	"	....	5, 43, 131
59	x.......	"	magnetite................	5, 159
	x.......	"	titanite, amphibole etc......	5, 159
	x.......	"	pyrrhotite................	5, 43
	....	"	pyrite....................	5, 43
	....	"	tourmalin, pyroxene........	43
	....	"	oligoclase, quartz..........	98
	....	"	pyroxene, albite............	5, 43
	x.......	"	pyroxene, titanite etc.......	5, 43
	x.......	"	amphibole................	98
	xx. ...	"	" titanite..........	98

NO	LOCALITY	SPECIES	DESCRIPTION
	Moriah (*continued*)		
60	Mill brook 2m. n.w. of Port Henry	calcite	crystals
		quartz	smoky
		pyroxene	
		graphite	small hexagonal crystals
61	Cheever mine 2m. n. Port Henry	magnetite	fine crystalline ore
		albite	greenish
		pyroxene	augite
	Newcomb		
62	Adirondack mines near Lake Sanford	magnetite	fine grained titaniferous
		labradorite	deeply striated
		hypersthene	
63	south shore Lake Harris 1m. e. of Newcomb	tourmalin	brown and green
		titanite	twinned crystals
		zircon	greenish black
		muscovite	yellowish green
		wernerite	semitransparent
		albite	opalescent mainly in druses
64	McIntyre 2m. s.e. Lake Sanford	labradorite	
		garnet	
		magnetite	
	North Elba		
65	*a*Cascadeville, 6m. s.e. Lake Placid	pyroxene	light green rounded grains
	Schroon		
66	Paradox Lake mines	magnetite	
		calcite	fine green translucent masses
		pyroxene	
		chondrodite	
		tourmalin	crystals
		wernerite	
	Ticonderoga		
67	Chilson lake (Paragon lake)	apatite	
		garnet	
		pyroxene	crystals and coccolite
		vesuvianite	
		wernerite	
		magnetite	
		calcite	blue

a This locality extends into Keene.

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
60	x	in white limestone	pyroxene, amphibole, albite	5, 43, 98
	x	"	calcite	6
		"	" amphibole etc.	43
		"	"	98
61	x*	Grenville schist		149, 194
		"	magnetite	5
		"	" labradorite	159
62	*†	in gabbro	labradorite, hypersthene	149, 194
		"	hypersthene	43
		"	labradorite	43
63	xx	in Grenville limestone	apatite, zircon etc.	135
	x	"	"	135
	x	"	tourmalin, apatite	135
		"		135
		"		135
		"		135
64	x	in gabbro	magnetite	43
		"		43
	x	"	labradorite	43
65		in calcite vein		159
66	*†	in Grenville limestone	proxene, chondrodite	194
	x	"	"	5,43
		"	wernerite, calcite	43
	x	"	tourmalin, wernerite	43
		"	chondrodite etc.	43
		"	pyroxene, calcite	5
67		contact gneiss and limestone		43
	x	"		43
	x	"		5,43
		"		5,43
	x	"	pyroxene, calcite	43
		"		43
		"		43

ESSEX

NO.	LOCALITY	SPECIES	DESCRIPTION
	Ticonderoga (*continued*)		
68	Kirby graphite mine 3m. n.w. Ticon'ga	graphite	crystals and folia
		pyroxene	large dark green crystals carrying inclusions of calcite
		wernerite	perfect crystals
		titanite	yellowish gray crystals
		tourmalin	black
		apatite	
		calcite	light yellow
		quartz	
69	Mount Defiance	pyroxene	salite
		magnetite	
		cacoxenite	
70	Rogers Rock	graphite	
		wollastonite	
		garnet	crystallized and massive colophonite
		orthoclase	brown, red and yellow adularia
		pyroxene	massive and granular coccolite
		titanite	abundant small, brown crystals
		calcite	masses of minute crystals
	Westport		
71	Splitrock mine 5m. n.e. Westport	magnetite	fine grain titaniferous
		graphite	
		labradorite	
		prehnite	chiltonite
	Willsboro		
72		wollastonite	
		garnet	colophonite
		pyroxene	green coccolite
		amphibole	hornblende in interesting forms
		quartz	milky

FRANKLIN

The rocks of this county afford no recorded mineral localities of sufficient importance

FULTON

The rocks of this county afford no recorded mineral localities of sufficient importance

GENESEE

Salt is mined and obtained in solution from the rocks of the Salina by drilling

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
68	xx*	in crystalline limestone and mica schist	calcite	43, 135
	xx	"	graphite wernerite	5, 43, 135
	x	contact limestone and gneiss	" pyroxene etc	5, 43, 135
		in white granular and lamellar feldspar	pyroxene, wernerite	5, 43, 135
		"	wernerite, pyroxene	5, 43, 135
			"	135
		vein mineral		135
		"		135
69				5
				194
				5, 43
70	x	in crystalline limestone	pyroxene titanite	43
	x	"	garnet, orthoclase	5, 43
	x	"		5, 43
		"		5, 43
	x	"	orthoclase, titanite	5, 43
		"		5, 43
		"		5
71	*†	in norite		149, 194
		"		*m*
		"		5, 43
		"		43
72	x	in vein traversing gabbro	garnet	5, 43
	x	"	wollastonite, pyroxene	5
	x	"	" titanite, garnet	5, 43, 175
		"	black tourmalin	5, 43
		"		*e*

COUNTY

to note in this list though minor localities undoubtedly occur in the crystalline rocks.

COUNTY

to note in this list though minor localities undoubtedly occur in the crystalline rocks.

COUNTY

through the Devonian rocks which cover the southern section of this county.

GREENE

NO.	LOCALITY	SPECIES	DESCRIPTION
	Catskill		
73	Diamond hill, Catskill	quartz	fine large crystals
74	Austin's glen 2m. n.w. Catskill	calcite	massive and coarsely crystallized
		quartz	small crystals
	New Baltimore		
75	limestone quarry at New Baltimore	calcite	interesting crystals
		quartz	crystals in parallel position

HAMILTON

The rocks of this county afford no recorded mineral localities of sufficient importance to note

HERKIMER

NO.	LOCALITY	SPECIES	DESCRIPTION
	Fairfield		
76	Diamond hill 3m. n.e. Fairfield	quartz	crystals
		barite	massive yellowish white
	Little Falls		
77	Little Falls	quartz	brilliant transparent crystals
		barite	yellowish white lamellar masses
		dolomite	white and pearly crystals
78	1m.s. L. Falls in bed of small stream	calcite	white crystals
		ankerite }	included under brown spar
		siderite }	included under brown spar
		orthoclase	flesh colored cleavages
	Newport		
79	Middleville	quartz	detached crystals and groupings
		calcite	flat crystals nail head type
		dolomite	white and pearly crystals
80	Newport	quartz	detached crystals
	Salisbury		
81	Salisbury	quartz	crystals larger than preceding
82	near Salisbury Center	sphalerite	
		galena	
		pyrite	
		chalcopyrite	
83		pyroxene	green coccolite
	Stark		
84	near Starkville	celestite	fibrous, bluish or blue
		gypsum	

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
73	x	embedded in stiff clay bot. layers of slate		5, 27, 43
74		veins in shale	quartz	*w*
		"	calcite	*w*
75	x	in Helderberg limestone		*p*
	xx	"		*e*

COUNTY

in this list though minor localities undoubtedly occur in the crystalline rocks.

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
76	x	in Beekmantown limestone	barite	5, 43
		"	quartz	5, 43
77	xx	in cavities in Beekmantown limestone	barite, calcite	5, 43
		" Beekmantown limestone	quartz dolomite	5, 43
		"	calcite quartz	5
78		Trenton limestone	siderite, orthoclase	5, 43
		"	calcite	43
		"		5
79	xx	in cavities in Beekmantown limestone	calcite, dolomite	5, 43
	x	" Beekmantown limestone	quartz "	5, 43
		" cavities in Beekmantown limestone		5, 43
80	x	"		5, 43
81	xx	"		5, 43
82		vein in gneiss		5, 43
		"		5, 43
		"		43
		"		5, 43
83		in Beekmantown limestone	calcite	5
84		in Salina waterlime	gypsum	5, 43
		"	celestite	43

JEFFERSON

NO.	LOCALITY	SPECIES	DESCRIPTION
	Adams		
85	near North Adams	fluorite	pink and green
		barite	
	Alexandria		
86	High island, St Lawrence river	tourmalin	long prisms
		amphibole	
		orthoclase	
		celestite	
87	Omar	beryl	
		hematite	
	Antwerp		
88	Antwerp, Sterling mine	hematite	bright flat crystals and massive red
		stilpnomelane	chalcodite in velvety brown masses
		siderite	small crystals and crystal. masses.
		ankerite	"
		millerite	capillary crystals lining cavities
		quartz	small transparent crystals
		"	chalcedony
		sphalerite	modified crystal (rare)
		serpentine	red and green concentric bands
89	*a*Oxbow, west shore of Yellow lake	calcite	large crystals and cleavages
		barite	porous coralloid
90	near Vrooman's lake	calcite	cleavage masses
		fluorite	green cubes
		pyrite	
		chalcopyrite	
		vesuvianite	terminated crystals
		phlogopite	
		pyroxene	green crystals
		titanite	
91	2m. s.w. Oxbow	limonite	bog iron ore
		serpentine	yellowish green
92		orthoclase	
		wernerite	
		tourmalin	yellow (rare)

a See also St Lawrence county.

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
85	....	in limestone........................	barite....................	43, 77
	....	"	fluorite..................	43, 77
86	x.......	in gneiss...........................	amphibole, orthoclase......	5, 43, 77
	....	"	tourmalin, orthoclase... ..	5, 43
	x.......	"	" etc..........	5, 43
	....	in limestone........................	....	43
87	x.......	" gneiss...........................	feldspar..................	43
	....	"	....	43
88	x*......	in gneiss...........................	siderite, quartz etc.........	5, 43
	xx	"	calcite, hematite...........	20, 43
	x.......	"	hematite..................	43
	x.......	"	"	43
	xx	"	"	43, 78
	....	"	" siderite etc.......	43
	x.......	"	" "	c
	x.......	"	"	w
	....	"	"	w
89	xx	in limestone........................	....	5, 43
	....	"	calcite....................	43
90	xx	vein in limestone....................	fluorite..................	43
	x.......	"	calcite...................	43
	....	"	....	43, 77
	....	"	....	43, 77
	....	"	pyroxene, titanite..........	43, 77
	xx	in gneiss...........................	"	43
	x.......	"	titanite, phlogopite.........	5, 43
	....	"	pyroxene..................	43, 77
91	x.......	"	orthoclase................	43
	x.......	in vein of crystalline limestone........	....	5, 43
92	x.......	" gneiss...........................	wernerite.................	43
	....	"	orthoclase, titanite.........	43
	....	"	....	43

NO.	LOCALITY	SPECIES	DESCRIPTION
	Brownville		
93	Brownville, banks of Black river......	celestite.......	slender crystals ....
		calcite.........	....
94	Pillar Point, Lee farm on n. shore.....	barite.........	massive banded structure ....
	Clayton		
95	near Depauville.....................	celestite.......	....
	Lyme		
96	Chaumont, Chaumont bay...........	"	slender white radiating needles...
	Philadelphia		
97	Shirtliff mine, Philadelphia...........	hematite.......	....
98	Indian river.........................	garnet.........	....
	Theresa		
99	Theresa............................	fluorite........	....
		calcite.........	....
		hematite.......	....
		amphibole.....	....
		serpentine	....
		celestite.....	white crystalline masses..........
		strontianite....	" ....
100	s.e. bank of Muscalonge lake.....	fluorite........	sea-green cubes................
		phlogopite.....	....
		chalcopyrite....	....
		apatite........	....
	Watertown		
101	banks of Black river.................	amphibole.....	white tremolite also brown & gray.
	Wilna		
102	Natural Bridge.....................	muscovite (gieseckite)	in six sided prisms pseudomorphs after nephelite................
		talc (steatite)..	pseudomorphs after apatite pyroxene, orthoclase etc............
103	1m. n. Natural Bridge...............	calcite.........	modified white crystals.. ......
	2m. e. Natural Bridge, *see* Lewis co.		

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
93	....	Trenton limestone..................	calcite....................	5, 43, *w*
	....	"	celestite..................	43, *w*
94	*†......	"	calcite....................	5, 43, 77, *w*
95	....	"	....	5
96	....	"	....	5, 43
97	*†......	in gneiss........................	....	194
98	x.......	"	....	43
99	x.......	gneiss limestone contact.............	calcite, quartz.............	43
	x.......	"	fluorite..................	43
	....	"	serpentine................	43
	....	"	....	43
	....	"	hematite..................	43
	....	"	calcite fluorite............	43, 77
	....	"	"	43
100	xx......	in limestone gneiss contact...........	calcite, apatite.............	5, 43
	x.......	"	"	43
	....	"	....	5, 43
	....	"	....	43
101	....	in Grenville limestone................	calcite....................	5, 43
102	xx	in decomposed Grenville limestone.....	....	43
	....	"	....	43
103	....	in Grenville limestone................	....	5, 43

LEWIS

NO.	LOCALITY	SPECIES	DESCRIPTION
	Diana		
104	2m. e. Natural Bridge (Ashmore's f'rm)	apatite	large green crystals
		wernerite	white, bluish and dark gray crystals
		pyroxene	dark green to black crystals augite
		amphibole	tremolite
		talc	rensselaerite
		wollastonite	abundant white crystals
		serpentine	variegated
		titanite	dark brown crystals
		zircon	rare
		quartz	doubly terminated crystals
		calcite	blue
		graphite	
		orthoclase	modified crystals
		hematite	
105	Harrisville, 2m. e. Bonaparte lake	wollastonite	large crystals
	Greig		
106	Greig	magnetite	
		pyrite	
	Martinsburg		
107	vicinity of Martinsburg, ½m. n.w. of Martinsburg	calcite	prismatic, terminated crystals
		fluorite	green, nearly transparent crystals.
		pyrite	
		galena	modified cubes
		sphalerite	granular, massive

LIVINGSTON

Salt and gypsum are obtained from the rocks of the Salina in a number of localities; see

MADISON

The rocks of this county afford no recorded mineral

MONROE

NO.	LOCALITY	SPECIES	DESCRIPTION
	Rochester		
108	Pike's quarry	dolomite	in geodes
		calcite	in geodes also stalactites
		gypsum	selenite and snowy

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
104	xx......	limestone syenite contact............	calcite....................	5, 43
	xx......	"	"	5
	xx......	"	wernerite.................	5, 43, 155 159, *j*
	x.......	"	calcite....................	43
	x.......	"	" serpentine	43, 77
	xx......	"	" pyroxene	5, 43, 77, *j*
	....	"	talc......................	43
	x.......	"	wernerite, pyroxene........	5, 43, *j*
	....	"	"	5, 43, 77
	x.......	"	....	43
	....	"	wernerite, pyroxene........	*j*
	....	"	"	43
	....	"	"	*j*
	....	"	"	43
105	....	in decomposed Grenville limestone.....	....	43, *c*
106	....	in gneiss.........................	....	43, 77
	....	"	....	43, 77
107	x.......	in Trenton limestone................	fluorite, galena etc..........	5, 43
	....	"	calcite, pyrite, galena.......	5, 43
	....	"	galena, sphalerite, fluorite...	5, 43
	....	"	pyrite, sphalerite...........	5, 43
	....	"	" galena..............	5, 43

COUNTY

ondary celestite, barite and calcite are also found in septaria in Genesee shale at several places.

COUNTY

localities of sufficient importance to note in this list.

COUNTY

108	x.......	in Niagara limestone..................	calcite, celestite, gypsum....	5, 43, *h*
	....	"	dolomite etc................	43, *h*
	....	"	"	43

MONROE

NO.	LOCALITY	SPECIES	DESCRIPTION
	Rochester (*continued*)		
	Pike's quarry (*continued*)	celestite	nodular
		fluorite	occasionally in cubes
		barite	massive snowy
		galena	
		sphalerite	honey-brown crystals
108a	Gorge of Genesee river	hematite	Clinton ore
			MONTGOMERY
	Palatine		
109	2m. e. Spraker's Basin	quartz	singly terminated crystals and drusy masses
		"	chalcedony
		garnet	
		anthracite	
	Root		
110	on Flat Creek 1½m. s.e. Spraker's B's'n	sphalerite	minute transparent light yellow crystals
		barite	lamellar masses
		galena	
		pyrite	massive
		calcite	stalactitic
		dolomite	brown and pearly
111	near Spraker's Basin	rutile	minute crystals

NASSAU

The rocks of this county are deeply covered with drift and artificially

NEW YORK

NO.	LOCALITY	SPECIES	DESCRIPTION
112	Corlaer's hook, Canal st. and East river	hypersthene	
113	Kip's bay, 34th st. and East river	heulandite	
114	38th st. and East river	epidote	
		orthoclase	pinkish crystals
115	42d st. and 4th av	siderite	spheric aggregates
		dolomite	crystals
116	43d–44th st. and 1st–3d av	molybdenite	disseminated scales
		calcite	crystals crusted with pyrite
		beryl	small crystals
		tourmalin	black crystals
		muscovite	large brown crystals
		oligoclase	
		garnet	
117	W. 35th st	garnet	large crystal, 6 inches diameter

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
		in Niagara limestone	dolomite etc.	5, 43
		"	"	5, 43
		"		43, *h*
		"	sphalerite	5, 43
		"	galena, calcite, gypsum	5, *h*
108a	*†	"		*m*

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
109		in gneiss	garnet	5, 43
		"	"	5, 43
		"	quartz	5, 43
		"		43
110		in Trenton limestone	galena, barite	5, 43
		"	" sphalerite, calcite	5, 43
		"	barite "	43
		"	" "	5, 43
		"	galena, sphalerite etc.	5, 43
		"		5
111		in Beekmantown limestone		5, 124

COUNTY

made land; deep excavations may however develop mineral localities

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
112		granite boulder		5, 28
113		on mica schist	stilbite	43
114		granite vein	orthoclase, prochlorite	5
		"	epidote	5, 43, *c*
115			dolomite	*e*
			siderite	*e*
116		in mica schist	kalinite	61
		"		61
		"		61
		quartz vein	oligoclase, muscovite	5
		"	" tourmalin	*c*
		"	muscovite "	*c*
		"	" "	*c*
117	xx	in mica schist	muscovite	43

NEW YORK

NO.	LOCALITY	SPECIES	DESCRIPTION
118	Between 42d and 51st st. and 4th and 5th av	cyanite	
119	49th st. and 1st av	beryl	
120	Between 54th and 62d st., 10th av. to river	amphibole	hydrous anthophyllite
		serpentine	dark green
121	55th–56th st. and 1st–3d av	siderite	sphaerosiderite
122	69th–70th st. and 2d av	ilmenite	
		garnet	
123	64th st. and 10th av	stilbite	small sheaflike aggregates
124	65th st. and Boulevard	garnet	large, handsome crystals
		orthoclase	crystals
125	10th av	vesuvianite	
		garnet	
126	85th-86th st. and 9th-10th av	siderite	sphaerosiderite
		albite	small fine crystals
127	95th-105th st. and 3d-Lexington av	ilmenite	
		garnet	
		stilbite	
		datolite	
128	100th-101st st. ana 5th av	epidote	granular, decomposed
		albite	small fine crystals
		ilmenite	thin plates
		chabasite	translucent flesh-colored crystals
129	102d st. and 4th av	garnet	crystals
		tourmalin	black
130	4th av. tunnel excavations	stilbite	radiated aggregates
		harmotome	small brown crystals
		apophyllite	
		natrolite	
131	120th st. and Hudson river	staurolite	small crystals
132	115th-122d st. and 4th-5th av	dumortierite	azure blue
		sillimanite	fibrolite
133	138th st. and 11th av	epidote	
134	155th st. and 10th av	xenotime	small well modified crystals
		monozite	
		zircon	small acutely terminated crystals
		garnet	" rough crystals

COUNTY *(continued)*

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
118		in hornblende schist	oligoclase, quartz, garnet	43
119	x	"		161
120		" mica schist	serpentine	5, 43
		"	amphibole	43
121		"		*c*
122		"	orthoclase	*c*
		"	"	*c*
123		"	pyrite	*e*
124	xx	"	albite	*e*
		"	muscovite	*e*
125		granite boulder	orthoclase, garnet	*c*
		"	vesuvianite	*c*
126		in crystalline schist	muscovite	*c*
		"	"	*c*
127		in mica schist	garnet, albite	*c*
		"	ilmenite	*c*
		on "	datolite	5
		"	stilbite	5
128		in "	mica	*w*
		"	on epidote	*w*
		in hornblende schist	clinochlore	*e*
		"	"	*e*
129		in mica schist	tourmalin	*e*
		"		*e*
130		on "	harmotome	5, 8
		"	stilbite etc.	5
		"	"	8
		"	"	8
131		in mica schist	garnet	5, 43
132	xx	" pegmatite vein	oligoclase, quartz	43, 49, 165
		" mica schist		43
133		" hornblende schist		43
134	x	" pegmatite vein	monozite	138, 170
		"	zircon, garnet	138
		in pegmatite vein	garnet, quartz	*e*
		"	zircon, quartz	*e*

NEW YORK

NO.	LOCALITY	SPECIES	DESCRIPTION
135	159th st. and 11th av	beryl	small opaque crystals
136	Washington h'ts 171st st. & 11th av	xenotime	small yellowish brown crystals
		monozite	small crystals and parallel growths
		zircon	small, slender, prismatic crystals
		dumortierite	filiform inclusions and fibrous
		muscovite	large crystals
		autunite	
137	176th-178th st. and 11th av	rutile	
		tourmalin	black
		garnet	almandite
138	180th st. & 10th av. (C. A. shaft 26)	serpentine	
		rutile	
139	200th st. and 10th av	cyanite	light yellow
140	Fort George	tourmalin	black
		muscovite	green rhombic crystals
		garnet	grossularite
		titanite	greenish yellow crystals
		orthoclase	crystallized
		oligoclase	moonstone
		zircon	minute crystals
		amphibole	hornblende and actinolite
		malachite	radiating tufts
		stilbite	sheaflike aggregates
		epidote	small brilliant crystals also gran'lar
141	½ m. s. of Kings bridge	amphibole	tremolite
		prochlorite	
		titanite	brown and black
142	Inwood	amphibole	hydrous anthophyllite
		tourmalin	small brown crystals
		pyroxene	
143	Kings bridge (ship canal)	pyrite	small brilliant crystals
		rutile	acicular, striated crystals
		pyroxene	malacolite
		tourmalin	green and brown prisms trigonal habit
		amphibole	tremolite

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
135	....	in pegmatite vein.................	quartz.............	*e*
136	x......	"	monozite, tourmalin........	82
	x.......	"	xenotime, tourmalin.......	82
	....	"	"	82
	....	....	"	82
	....	"	"	82
	....	"	quartz, muscovite..........	82
137	....	in mica schist......................	calcite.....................	*e*
	....	" pegmatite vein	quartz, orthoclase..........	*e*
	....	"	"	*e*
138	....	....	....	131
	....	in crystalline limestone...............	pyrite.....................	*e*
139	....	in pegmatite vein..................	orthoclase..................	*e*
140	....	"	" quartz...........	*e*
	xx	"	"	*e*
	....	"	" muscovite	*e*
	x.......	"	"	*e*
	....	"	muscovite, tourmalin.......	*e*
	....	"	quartz.....................	*e*
	....	"	" tourmalin........	*e*
	....	"	orthoclase, quartz..........	*e*
	x.......	"	"	*e*
	....	"	"	*e*
	....	"	"	*e*
141	....	in dolomitic limestone...............	graphite...................	5
	....	"	amphibole..................	5
	....	"	"	5
142	....	"	serpentine	43
	....	"	....	43
	....	....	....	*m*
143	x.......	in dolomitic limestone...............	rutile, amphibole...........	5, 43, 133
	....	"	quartz, dolomite...........	5, 133
	....	"	tourmalin, muscovite.......	43
	....	"	amphibole pyrite..........	5, 43
	....	"	rutile....................	5, 43

NEW YORK

NO.	LOCALITY	SPECIES	DESCRIPTION
	Kings bridge (ship canal)	muscovite	pale green, transparent crystals
		quartz	clear and smoky crystals
		dolomite	crystals and massive
144	1m. n.e. Central bridge	clinochlore	green scales
145	Tremont (H. R. R. cut)	kaolinite	gray, red and yellow
146	Morrisania	tourmalin	brown
147	Spuyten Duyvil	amphibole	asbestos
148	West Farms	titanite	small, reddish brown prisms
		epidote	
		amphibole	tremolite
		chabazite	crystals lining walls of seams
		heulandite	"
		stilbite	"
		apatite	
		garnet	

NIAGARA

NO.	LOCALITY	SPECIES	DESCRIPTION
	Lewiston		
149		epsomite	
		calcite	lining geodes
		chalcopyrite	
	Lockport		
150	Lockport (canal cutting)	celestite	lamellar, white and bluish white, opaque to transparent. Lining geodes
		calcite	white and yellow dogtooth spar
		gypsum	selenite and snowy
		anhydrite	blue, massive
		fluorite	occasionally in cubes
		dolomite	white & pink crystals lining geodes
		sphalerite	honey and wax yellow crystals, often transparent
	Niagara		
151	Niagara Falls	calcite	crystals lining geodes
		dolomite	pink to white crystals
		fluorite	
152	Niagara Falls, Goat island	sphalerite	in imperfect crystals

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
	....	in dolomitic limestone...............	amphibole, pyrite..........	5, 43, 133
	....	"	dolomite pyrite............	133, *c*, *e*
	....	"	quartz etc.................	5, 133
144	....	"	....	43
145	....	"	....	123, 126
146	....	in pegmatite vein	....	*e*
147	....	" mica schist.....................	....	43
148	....	granite dikes.....................	epidote, amphibole.........	5, 43
	....	"	amphibole, orthoclase	5, 43
	....	"	quartz etc................	5, 43
	....	"	stilbite, heulandite.........	5, 43
	....	"	chabasite, stilbite..........	5, 43
	....	"	heulandite.................	5, 43
	....	in mica schist.....................	garnet, muscovite..........	5, 43
	....	"	muscovite..................	5, 43

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
149	....	on limestone.....................	....	43
	....	in "	....	5
	....	"	malachite (?)..............	5
150	x	in Niagara limestone	calcite, dolomite etc.........	5, 43, *k*
	xx	"	dolomite, celestite etc.......	43, *k*
	x	"	" anhydrite..........	5, 43, *k*
	x	"	calcite, gypsum............	5, 43, *k*
	x	"	celestite "	5, 43, *k*
	x	"	calcite,celestite,gypsum.....	5, 43, *k*
	....	"	....	5, 43
151	x	in Niagara limestone................	dolomite, celestite..........	43
	x	"	calcite, celestite, gypsum....	5, 43
	....	"	"	43
152	....	in Lockport limestone................	....	5, 43

ONEIDA

NO.	LOCALITY	SPECIES	DESCRIPTION
	Boonville		
153	near Boonville w. bank Dry Sugar river	calcite	prismatic and nail head crystals
		wollastonite	
		pyroxene	coccolite
		garnet	
	Kirkland		
154	Clinton, near Hamilton College	sphalerite	yellow, nearly transparent crystals
		strontianite	in geodes, coating celestite
		celestite	in geodes
155	Elliott and Paddon mines	hematite	oolitic
	New Hartford		
156	Davis ore bed	hematite	oolitic
		wollastonite	fibrous
	Rome		
157	near Rome	sphalerite	yellow, massive
	Vernon		
158	near Vernon	"	"
	Verona		
158a	Verona	hematite	oolitic

ONONDAGA

NO.	LOCALITY	SPECIES	DESCRIPTION
	Camillus		
159	Camillus railroad cut	gypsum	selenite and fibrous
		sulfur	small masses in beds of earthy gypsum
		calcite	small incrusting crystals & fibrous
	Manlius		
160	Fayetteville 1m. n. of town	gypsum	occasionally in crystals, selenite
		fluorite	deep purple cubes
	Salina		
161	Liverpool	gypsum	fibrous
162	Syracuse	halite	brine solution from wells etc
		serpentine	
		perofskite	
		celestite	
		gypsum	selenite
		barite	interlaced plates

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
153	x	veins in limestone		43
	x	in boulders	garnet pyroxene	5, 43
	x	"	" wollastonite	5, 43
		"	pyroxene "	5, 43
154		in shale and sandstone	hematite	5
		" Clinton and Niagara limestone	celestite	43, 168
		"	strontianite	43
155	*†	in shale and limestone		149, 194
156	*	"		149, 194
		"		71
157				5
158				5
158a	*†	Clinton shale and limestone		149

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
159		in Salina waterlime	sulfur	5, 43
		"	gypsum	5
		"	"	43
160		"	fluorite	5, 43, *p*
		"	gypsum	5, 43
161		in Salina		186
62	*	"		66, 121, 192
	x	"	perofskite	225, 226
		"	serpentine	226
		"	gypsum, barite	43
		"	celestite "	43
		"	gypsum celestite	5, 43

ONTARIO

The Devonian rocks of this county have been suc-

ORANGE

NO.	LOCALITY	SPECIES	DESCRIPTION
	Blooming Grove		
163	Craigsville	quartz	crystals and heliotrope
164	½m. n.w. Washingtonville	labradorite	
	Cornwall		
165	Deer hill 3m. s. of Cornwall	ilmenite	
		serpentine	
	Highlands		
166	Bog Meadow pond 3m. w. of W. Point	zircon	white, reddish brown & black
		chondrodite	granular
		spinel	black and green
		orthoclase	white, opalescent
		epidote	massive and somewhat fibrous
		pyroxene	coccolite
		amphibole	
167	4m. s.e. Woodbury furnace	"	
		calcite	
		fosterite	boltonite
		magnetite	
		spinel	
168	Forest of Dean mine	pyroxene	coccolite, sahlite
	5m. s.w. West Point	forsterite	boltonite
		spinel	large crystals, black and green
		magnetite	
		amphibole	pargasite
		wernerite	
		zircon	reddish brown and black
169	West Point	molybdenite	
		amphibole	tremolite, actinolite
		tourmalin	
		garnet	common
		epidote	
		pyroxene	diallage
		orthoclase	in crystals often flesh-color
		mica	
		wernerite	large, white, compact masses
		titanite	
		allanite	tabular crystals

COUNTY.

cessfully drilled for natural gas in several localities.

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
163	....	veins in slate........	....	5, 43
164	....	....	....	43, 74
165	....	....	....	5, 43
	....	....	....	5, 43
166	x	in crystalline limestone........	chondrodite, spinel........	5, 43
	x	"	spinel etc........	5, 43
	x	"	chondrodite, zircon	5, 43
	x	"	epidote	5
	x	"	orthoclase	5, 43
	....	"	....	43
	....	"	....	5, 43
167	....	in gneiss limestone contact........	spinel etc........	5, 43
	....	"	amphibole........	74
	x	"	....	74
	....	"	....	74
	....	"	....	74
168	x	in crystalline limestone	spinel wernerite	74, 43
	....	"	pyroxene........	74
	x......	"	"	43, 74, 5
	*......	"	spinel, pyroxene........	74, 149, 194
	....	"	"	43,74
	....	"	"	43, 74
	....	"	"	43, 74
169	....	in gneiss........	tourmalin........	35
	x	" syenite........	....	35
	....	" gneiss........	molybdenite........	35
	....	"	tourmalin........	35
	....	"	" pyroxene........	35
	....	"	" titanite........	35, 95
	x	"	"	5, 43
	x	"	"	43
	....	"	pyroxene........	5, 43
	x	"	"	43
	....	"	" wernerite........	43, 10

NO.	LOCALITY	SPECIES	DESCRIPTION
	Highlands (*continued*)		
170	West Point, Constitution island......	molybdenite...	....
		magnetite.....	....
	Monroe		
171	O'Neil mine 1m. e. Mombasha........	magnetite.....	large grains....................
	2m. s.w. Turners....................	garnet..........	colophonite.....................
		pyroxene......	large, greenish black crystals.....
		"	coccolite, green.................
		amphibole.....	hornblende, amianthus... ......
		serpentine.....	yellow and black...............
		dimagnetite.....	perhaps a magnetic pseudomorph after ilvaite..................
		biotite.........	....
		hortonolite.....	....
172	Clove mine near Turners.............	biotite.........	....
		amphibole.....	hornblende, asbestos............
		orthoclase......	....
		serpentine......	....
		hydrophite.....	jenkinsite......................
		calcite.........	....
		chromite.......	....
	Mt Hope		
173	Erie mine, Guymard................	galena.........	....
	Tuxedo		
174	Tuxedo Park.......................	epidote........	....
175	½m. e. Arden.......................	pyroxene......	green, grayish green and gray crystals.........................
		biotite.........	anomite........................
		chondrodite....	light yellow grains............
		spinel..........	black and green.............
		wernerite......	meionite......................
		amphibole.....	hornblende....................
176	3m. s.e. Arden......................	pyroxene......	salite, coccolite ....
177	Greenwood furnace, Arden...........	"	diopsid.......................
		chondrodite....	....
		biotite.........	anomite.......................
		spinel..........	....

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
170	....	in gneiss........................	....	35
	....	"	....	35
171	x*†....	"	serpentine, pyroxene	149
	x......	"	"	5,43,74,149
	....	"	magnetite, garnet..........	5, 74
	....	"	"	5, 74, 149
	....	"	"	5, 43, 74
	....	"	"	5, 43, 74
	....	"	"	43, 181
	xx	"	"	43
	......	"	on pyroxene...............	139
172	....	in limestone........................	serpentine, amphibole etc....	5
	....	"	biotite....................	5, 43
	....	"	....	5
	....	"	....	5
	....	"	....	191
	....	"	....	5
	....	"	....	5
173	*†......	in limestone........................	....	5
174	x.......	....	....	5, 43
175	xx......	in crystalline limestone	mica......................	5, 43
	xx......	"	pyroxene..................	5
	x.......	"	spinel....................	5, 43
	x......	"	chondrodite...	5, 43
	x.......	"	pyroxene, mica............	5, 43
	....	"	"	5, 43
176	....	"	....	5, 43
177	xx.. .	in gneiss........................	wernerite, spinel...........	51, 43
	x.......	"	spinel.....................	43
	xx......	"	wernerite, pyroxene........	43
	x.......	"	"	43

ORANGE

NO.	LOCALITY	SPECIES	DESCRIPTION
	Tuxedo (*continued*)		
	Greenwood furnace, Arden	wernerite......	....
		amphibole.....	....
		ilmenite.......	....
	Warwick		
178	1m. s.w. Amity....................	spinel.........	green, black, brown and red very large crystals.................
		chondrodite....	rounded grains and crystals.......
		corundum......	white, blue and reddish crystals..
		tourmalin......	yellow and cinnamon crystals.....
		clinochlore.....	leuchtenbergite.................
		phlogopite.....	....
		fluorite........	....
		amphibole.....	large and perfect crystals.........
		magnetite	in scattered grains...............
		ilmenite.......	interesting crystals..............
		garnet.........	grossularite.....................
179	½m. s.e. Amity	spinel.........	large octahedral crystals.........
		corundum.....	bluish white.....................
		amphibole.....	hornblende......................
180	Amity............................	spinel.........	grayish red, twinned octahedrons..
		warwickite.....	....
		seybertite......	clintonite......................
		talc...........	common and foliated varieties....
		ilmenite.......	fine crystals....................
		garnet.........	cinnamon brown crystallized and massive......................
		wernerite......	milk white crystals, dendritic surfaces......................
		pyroxene......	light brown crystals, leucaugite...
		"	augite and coccolite.............
		enstatite.......	bronzite........................

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
	x	in gneiss	pyroxene	43
		"	ilmenite	43
		"	amphibole	43
178	xx	in granular limestone and serpentine	chondrodite, hematite	5, 43, 176
	x	"	spinel, tourmalin	43
	x	"	" rutile	5, 43
	x	in calcite	"	5, 43, 74
		"	amphibole, phlogopite	43
		"	" fluorite	43
		"	spinel, tourmalin	43, 74
	x	"	phlogopite, graphite	5, 43,74,176
		"	chondrodite	43
	x	"	spinel	176, 74
		"	amphibole etc.	74
179	x	in crystalline limestone	corundum	74, 176
		"	amphibole spinel	74, 176
		"	spinel, corundum	74, 176
180	xx	" and serpentine	ilmenite	5, 43, 74, 176, 212
		"	"	43, 178, 190
	x	"	"	5, 43, 74
	xx	"	" seybertite	5, 43
		"	spinel	5 43, 85
	x	in crystalline limestone	pyroxene	43, 176
	x	"	" titanite	5, 43, 74, 176
	xx	"	calcite, seybertite	5, 41, 43, 119, 159
		"	wernerite, titanite	74, 176
		"	spinel, pyroxene	57, 176

NO.	LOCALITY	SPECIES	DESCRIPTION
	Warwick (*continued*)		
	Amity (*continued*)	amphibole	pargasite, amianthus
		vesuvianite	grayish and yellowish brown crystals, xanthite
		titanite	in small crystals
		zircon	large brown crystals (rare)
		orthoclase	crystallized
		tourmalin	clove brown
		rutile	brown to pale red crystals
		chondrodite	pink
181	2m. s.w. Amity	apatite	fine crystals, emerald and bluish green
		rutile	dark blue terminated prisms
182	2m. s.e. Amity	epidote	rich grass-green crystals
183	2m. w. Amity	rutile	black, gray and reddish brown crystals
184	Edenville	chondrodite	blood-red, orange and buff
		titanite	light brown crystals
		tourmalin	gray, bluish, green and black
		scorodite	small crystals and druses
		arsenopyrite	crystals and massive
		leucopyrite	abundant
		warwickite	hair-brown grains
		yttrocerite	purple
		sphalerite	opaque, black
		vesuvianite	
		quartz	hornstone
185	1m. n. of Edenville	orthoclase	crystallized
		fluorite	
		amphibole	tremolite and hornblende
		vesuvianite	
		tourmalin	
		titanite	
		spinel	
		zircon	red and white
		orpiment	slight traces

COUNTY *(continued)*

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
		in crystalline limestone	spinel, pyroxene	74, 176
	x	"	"	5, 43, 74, 176, 212
		"	"	5, 43, 74, 176
	x	"	wernerite garnet	43, 176
	x	"	"	74
	x	"	amphibole, rutile	5, 43
		"	tourmalin and quartz	5, 43
		"	calcite and serpentine	74, 141, 176
181	x	in crystalline limestone	pyroxene	5, 43, 176
		"	spinel, chondrodite	5, 43
182	xx	in quartz		5, 43
183		" crystalline limestone	spinel corundum	5, 43
184	xx	"	spinel	5, 43, 141
		"	hornblende	5, 43
		"	"	5, 43
		"	arsenopyrite	5, 43, 74
		"	scorodite, gypsum	43, 74
	x	"	hornblende	43
	x	"	chondrodite	43, 178
	xx	"	silvery muscovite	43
		"		c
		"		43
		"		43
185		limestone granite contact	amphibole spinel	74
		"		74
		"		74
		"		74
		"		74
		"		74
		"		74
		"		74
		"		74

NO.	LOCALITY	SPECIES	DESCRIPTION
	Warwick (*continued*)		
186	southern base of Mt Eve 2½m. n. of Edenville	amphibole	edenite, dark hair-brown crystals.
		pyroxene	gray crystals
		wernerite	
		zircon	chocolate brown crystals
		orthoclase	
		spinel	
		fluorite	purple
187	1m. n. w. Edenville	pyroxene	augite
		amphibole	dark green, gray or brown crystals
		muscovite	six sided and rhombic prisms
		rutile	
		chondrodite	
188	4m. w. Edenville	ilmenite	
189	1m. e. Edenville	rutile	
190	1m. s. Edenville	amphibole	dark green, gray or brown crystals
191	Warwick	spinel	soft, pseudomorphous crystals
		serpentine	sometimes in large pseudomorphous crystals
		ilmenite	crystals
		pyroxene	coccolite
		amphibole	
		warwickite	
192	Rocky hill 3m. s.e. Warwick	magnetite	
		marcasite	terminated crystals
		titanite	large grayish brown crystals
		zircon	brown
		rutile	square terminated prisms
		wernerite	
		orthoclase	interesting crystals
		tourmalin	
		seybertite	clintonite
193	2 m. e. Warwick	magnetite	
		marcasite	
		arsenopyrite	
		pyrite	in cubes
		molybdenite	in irregular plates

COUNTY *(continued)*

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
186	xx. ...	in crystalline limestone.............	wernerite, pyroxene........	5, 43, 176
	x	"	" zircon...........	5, 43, 176
	....	"	pyroxene.................	5, 43, 176
	x	"	" wernerite.........	5, 43, 176
	....	"	....	5, 43
	....	"	....	176
	....	"	....	176
187	x	"	amphibole................	5, 43
	x	"	pyroxene mica	5,43,74,176
	....	"	"	5, 43, 176
	....	"	"	5, 43, 176
	....	"	....	74, 141
188	....	gneiss limestone contact	spinel chondrodite	5, 43
189	....	in limestone boulders................	amphibole................	5, 43
190	....	" crystalline limestone	titanite chondrodite	5, 43
191	xx	"	serpentine	5, 43
	xx	"	pyroxene spinel............	5, 43
	....	"	spinel, chondrodite.........	5, 43
	....	"	amphibole, spinel..........	5, 43
	....	"	pyroxene, spinel...........	5, 43
	....	"	"	178, 190, a
192	*†.. ...	in gneiss............................	....	194
	....	"	magnetite	176
	....	"	zircon etc.................	5, 43
	....	"	orthoclase, tourmalin.......	43, 176
	....	"	zircon....................	176
	....	"	" amphibole	5, 43
	xx	"	tourmalin zircon	5, 43
	....	"	orthoclase	43
	x	"	"	43
193	*†... ..	in limestone.........................	garnet....................	74, 176
	....	"	zircon....................	5, 43
	....	"	mica, pyrite..............	43
	....	"	marcasite.................	5
	....	"	rutile, zircon, pyrite........	5, 43

ORANGE

NO.	LOCALITY	SPECIES	DESCRIPTION
	Warwick (*continued*)		
	2 m. e. Warwick	rutile	octagonal prisms
		quartz	small ferruginous crystals
		garnet	
194	Sterling mines, Sterling lake	magnetite	granular
		amphibole	crystals
		pyroxene	
		epidote	small crystals
		orthoclase	red and white
		tourmalin	
	Woodbury		
195	Queensbury forge 2½ m. s. w. Fort Montgomery	spinel	black and green
		sillimanite	monrolite, bucholzite
		garnet	colophanite
		rastolite	
		amphibole	
		ilmenite	good crystals
		pyrrhotite	
		pyrite	massive
196	Bradley mine n. Cedar pond	magnetite	crystals embedded in calcite
		pyrrhotite	
		apatite	crystals embedded in calcite
		pyroxene	granular and short green crystals
		titanite	crystals embedded in calcite
197	Fall hill 3 m. e. Central Valley	wernerite	white and bluish
198	Twin lakes (Two ponds)	pyroxene	gray to brown prismatic crystals
		wernerite	large reddish white crystals
		chondrodite	granular, light yellow
		zircon	large crystals
		amphibole	green actinolite and hornblende
		titanite	abundant in large crystals
		apatite	

ORLEANS

The rocks of this county afford no recorded mineral

OSWEGO

The rocks of this county have been successfully drilled

OTSEGO

The rocks of this county afford no recorded mineral

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
	x	in limestone	zircon	5, 43
		"		5, 43
		"		74
194	*	in gneiss	apatite	149, 194
		"	pyroxene	160
		"	epidote	160
		"	pyroxene	160
		"	magnetite, tourmalin	160
		"	quartz	160
195	x	"	mica, garnet, magnetite	5, 43
		"	"	5, 43
	x	"	mica, spinel etc	5, 43
		"		43
		in serpentine and white limestone		43
		"	spinel, chondrodite, rutile	5, 43
	x	"		43
		"		5, 43
196	*	in gneiss	calcite	160
		"		160
		vein in gneiss	calcite, augite	160
		"	apatite, titanite etc	160
		"	pyroxene, apatite	160
197		in gneiss	lamellar pyroxene	5, 43
198	xx	in crystalline limestone	wernerite, zircon etc	5, 43
	xx	"	pyroxene, titanite	5, 43
	x	"	spinel	5, 43
	x	"	wernerite, pyroxene	5, 43
		"	"	5, 43
		"	"	5. 43
		"	"	5. 43

COUNTY

localities of sufficient importance to note in this list.

COUNTY

for natural gas; no notable mineral localities are recorded.

COUNTY

localities of sufficient importance to note in this list.

PUTNAM

NO.	LOCALITY	SPECIES	DESCRIPTION
	Carmel		
199	near Carmel, boulder in road	epidote	sharp, well defined crystals
200	2m. s. Carmel	"	translucent crystals and massive
201	Mahopac group of mines	magnetite	medium fine grained
	Kent		
202	2m. n.e. Carmel	amphibole	actinolite
203	Brown's quarry 4m. n.w. Carmel	arsenopyrite	in good crystals
		amphibole	radiated anthophyllite
	Patterson		
204	1m. w. Towners	pyroxene	grayish white crystals
		calcite	scalenohedral crystals
		amphibole	asbestos and tremolite
		dolomite	
		pyrite	massive
	Philipstown		
205	Cold Spring	titanite	
		epidote	
		pyroxene	
206	Hustis quarry 4m. n.e. Cold Spring	amphibole	tremolite, amianthus
		serpentine	many varieties
		titanite	
		pyroxene	diopsid, green coccolite
		wernerite	small white opaque crystals
		dolomite	semiopaline, conchoidal fracture
207	Cotton rock 3½m. s. of Garrisons (this locality has been obliterated by the N.Y.C.R.R. embankment)	serpentine	
		amphibole	silky amianthus
		pyroxene	diallage and augite
		stilbite	crystals and fanlike groups
		laumontite	occurs sparingly
	Putnam Valley		
208	Denny and Todd mines 6m.n.e. Peekskill	magnetite	
		chromite	
		calcite	small crystals on magnetite
209	Phillips' ore bed (this bed outcrops at intervals in the towns of Philipstown and Putnam Valley following a valley formerly known as Canopus hollow)	magnetite	
		pyrite	massive
		amphibole	actinolite
		opal	hyalite in thin coatings

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
199	x	in granite boulder		6
200		in gneiss	amphibole, garnet	5, 43
201	*†	"		149, 194
202		in gneiss		5
203		"	amphibole	43
		serpentine in gneiss	arsenopyrite, epidote	5, 43
204	xx	in dolomitic limestone		5, 43
	x	"	asbestos	43
	x	"	calcite	5, 43
		"	"	43
		"		5,43
205	†	in gneiss		5, 43
		"		5, 43
		"		5, 159
206	*†	in crystalline limestone	serpentine	5, 43, *g*
	x*†	"		5, *g*
		"		43, *g*
		"	serpentine, apatite	5, 159
		"	titanite, apatite, quartz	5, 43, *g*
	*†	"		5, 43
207	†	"	amphibole	5, 43
	†	"	serpentine	5, 43
	†	"	"	5, 43
	†	"		5, 43
	†	"		5, 43
208	*†	gneiss limestone contact	chromite	43, 149, 194
		"		43
		"	magnetite chromite	5, 43
209	*†	in gneiss		5, 43, 194
		"	magnetite, amphibole	5, 43
		"	"	5, 43
		on "		43

PUTNAM

NO.	LOCALITY	SPECIES	DESCRIPTION
	Southeast		
210	Tilly Foster mine 2m. n.w. Brewster...	chondrodite....	deep red crystals, highly modified
		clinohumite....	"
		humite........	"
		magnetite......	dodecahedral crystals and massive
		dolomite.......	....
		serpentine	light and dark green, mottled with red........................
		"	pseudomorphs in many forms.....
		brucite........	crystallized and pseudomorph after dolomite...................
		enstatite.......	....
		clinochlore.....	in large crystals,...............
		prochlorite.....	....
		biotite.........	....
		amphibole.....	actinolite, light green fibrous .....
		pyrrhotite	....
		fluorite........	colorless to purple crystals ....
		albite	....
		epidote........	small crystals..................
		titanite........	transparent greenish crystals often twinned...................
		hydrotalcite....	white fibrous..................
		calcite.........	scalenohedral and nail head types.
		garnet.........	oil-green dodecahedral crystals....
		apatite.......	....
		datolite.......	....
		stilbite........	....
		prehnite.......	....
		apophyllite	....
		tourmalin......	....
		molybdenite....	....
		pyroxene......	dark green coccolite.............

QUEENS

The rocks of this county are deeply covered with drift and artificially

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
210	xx.......	in gneiss..........	magnetite, clinochlore......	1, 16, 37, 38, 43, 141, 170
	x.......	"	"	43, 141
	x.......	"	"	43, 141
	x*†.....	"	serpentine, clinochlore......	43, 149, 170, 194
	x.......	"	magnetite, chondrodite.....	43, 170
	x.......	"	"	16, 43, 170
	x.......	"	"	42, 43
	x.......	"	prochlorite..........	42, 43, 170
	x.......	"	"	16, 43, 170
	xx......	"	chondrodite..........	16, 43, 170
	....	"	clinochlore..........	16, 43, 170
	....	"	....	16, 43
	....	"	....	5, 16, 43
	....	"	....	43, 170
	....	"	calcite..........	43, 170
	....	"	....	43
	....	"	pyroxene, amphibole.......	43, 170
	xx......	"	magnetite, apatite	43
	x	"	" prochlorite......	*w*
	....	"	brucite, dolomite..........	170
	....	"	....	43, 170
	x	"	....	43
	....	"	....	43
	....	"	....	43
	....	"	....	43
	x	"	....	43
	....	"	....	43, *w*
	....	"	magnetite serpentine	*w*
	....	"	hornblende, epidote........	*w*

COUNTY

made land; deep excavations may however develop mineral localities.

RENSSELAER

NO.	LOCALITY	SPECIES	DESCRIPTION
	Brunswick		
211	Lansingburg	quartz	large doubly terminated crystals
212	South Troy	"	"

RICHMOND COUNTY

NO.	LOCALITY	SPECIES	DESCRIPTION
213	Tompkinsville[a] and southward to New Dorp	serpentine[b]	red and green (slickensides)
		"	asbestos and amianthus
		talc	greenish white, foliated
		dolomite	
		brucite	white, foliated
		magnesite	massive in veins and cavities
		aragonite	minute needlelike crystals
		chromite	minute octahedrons
		pyrolusite	thin dendrites
		deweylite	
		anhydrite	massive
214	iron mines w. of Concord and w. of Garretsons	limonite	oolitic and spongy
		quartz	green quartz in small crystals
215	Rossville on shore of Arthur kill	lignite	
		pyrite	crystals and nodules

ROCKLAND

NO.	LOCALITY	SPECIES	DESCRIPTION
	Haverstraw		
216	Ladentown 1½m. n.w. of Pomona	cuprite	
		malachite	
		zircon	brilliant brown to black crystals
217	Haverstraw	amphibole	hornblende in small crystals
	Orangetown		
218	Piermont, excavations for the Erie R. R.	datolite	
		stilbite	in minute crystals
		apophyllite	
		pectolite	
		prehnite	

a A fresh exposure occurs in Westervelt av. between 1st and 2d av.
b Serpentine also occurs in frequent outcrops along the ridge extending southwest from

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
211	x	....	....	e
212	....	....	....	e

AND BOROUGH

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
213	....	serpentine rock	talc, brucite etc.	5, 43, 94
	x	"	"	5,43,94,144
	x	"	serpentine, magnesite	5, 43
	x	"	"	5, 43
	....	"	"	5, 43
	....	"	serpentine, brucite	5, 43
	....	"	"	43
	....	"	serpentine	w
	....	"	on talc	w
	....	"	serpentine, brucite	w
	....	"	talc, brucite	w
214	*†	serpentine	yellow clay and quartz	18, 23, 67 149
	....	"	limonite	67
215	....	in clay	pyrite	5, 43
	....	"	lignite	5, 43

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
216	....	in red Triassic shale	malachite	5, 43
	....	"	cuprite	43
	....	in granite boulder	....	5, 43
217	....	" shale	....	5
218	....	in diabase	apophyllite, stilbite	43
	....	"	datolite, zeolites	5, 43
	....	"	"	5, 43
	....	"	"	5, 43
	....	"	" calcite	5, 43

Tompkinsville to New Dorp.

ROCKLAND

NO.	LOCALITY	SPECIES	DESCRIPTION
	Orangetown (*continued*)		
	Piermont, excavations for the Erie R. R. (*continued*)	thomsonite	
		chabazite	
		calcite	in minute crystals
		tourmalin	
	Stony Point		
219	Dunderberg mine n. side Dunderb'g mt	magnetite	lean ore
220	Stony Point, north shore	zoisite	
		pyroxene	green augite
		amphibole	hornblende, light green
		titanite	
		pyrite	small crystals
		chrysolite	
		garnet	
		staurolite	minute crystals
221	Tomkins Cove	calcite	white and yellowish crystals
		barite	minute tabular crystals
222	2½m. n.w. Grassy Point	amphibole	radiated and interlaced actinolite
		orthoclase	minute crystals
		epidote	small granular masses

ST LAWRENCE

NO.	LOCALITY	SPECIES	DESCRIPTION
	Canton		
223	Pyrite mines 2m. s. Canton	pyrite	massive
		chalcopyrite	
		hematite	
		calcite	
		serpentine	
		talc	rensselaerite
		tourmalin	brown
		titanite	
		pyroxene	
	De Kalb		
224	3m. s. DeKalb Junction	"	diopsid, transparent crystals
		datolite	rare
225	5m. s.w. DeKalb Junc. (Mitchel farm)	pyroxene	diopsid
		calcite	crystallized and massive
		quartz	

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
	....	in diabase..........................	zeolites, calcite............	5, 43
	....	"	"	5, 43
	....	"	"	5, 43
	....	"	....	*a*
219	*†......	" gneiss...........................	pyrite....................	194
220	....	" diorite limestone contact...........	amphibole, pyroxene.......	5, 45, 228
	....	"	"	45, 96, 159, 228
	....	"	pyroxene.................	5,45,96, 228
	....	"	amphibole wernerite.......	159, 228
	....	on peridotite.......................	calcite	*e*
	....	in "	....	96, 44
	....	" diorite..........................	....	44
	....	" mica schist.......................	....	44
221	x.......	" Stockbridge limestone.............	....	5, 43
	....	"	calcite	5
222	....	in limestone........................	epidote etc...............	5
	....	"	amphibole, epidote.........	5
	....	"	orthoclase "	5

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
223	x*......	gneiss limestone contact.............	chalcopyrite	43
	....	"	pyrite....................	43
	....	"	....	43
	x	"	....	43
	....	in granular limestone...............	....	43
	....	"	....	43
	....	"	....	43
	....	"	....	43
	....	"	....	43
224	xx	gneiss limestone contact	pockets in clay	5, 43, 151
	....	"	pyroxene.................	43
225	xx	in clay pockets in talc	calcite...................	5, 43, 151, *w*
	....	"	pyroxene quartz...........	*w*
	....	"	....	*w*

NO.	LOCALITY	SPECIES	DESCRIPTION
	De Kalb (*continued*)		
226	3m. w. De Kalb Junction	talc	massive fibrous
		tourmalin	colorless glassy crystals
		amphibole	dark green hornblende
		phlogopite	
		serpentine	
227	near Osborn's lake	fluorite	large cubic crystals
		tourmalin	
		calcite	crystals
		barite	
		amphibole	white and gray tremolite
		phlogopite	
228	Richville	barite	long tabular crystals
	Edwards		
229	Talcville, talc mines	talc	massive, fibrous
		amphibole	hexagonite schist of interlaced crystals
		pyrolusite	small but perfect dendrites
		enstatite	rather rare
230	Anthony mine 2m. s. Edwards	amphibole	actinolite, tremolite
		wernerite	
		apatite	
		phlogopite	light green and sea-green plates
		hematite	
		magnetite	
		serpentine	
	Fine		
231	Scott farm	oligoclase	crystals, moonstone
		pyroxene	brilliant crystals
		zircon	
		titanite	
		fluorite	
		calcite	
		pyrite	
232	Benson mines	magnetite	
233	Clifton mines	"	

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
226	*	in limestone	amphibole	w
	xx	"	" pyroxene	43
	x	"	pyroxene	43,
	x	"	" amphibole	43
		"		43
227	x	in gneiss	calcite	43
	x	"	" fluorite	43
		"	fluorite	43
		"	calcite, fluorite	43
		"	phlogopite	5, 43
		"	amphibole etc.	43
228	xx	in limestone		24, 43
229	*	in gneiss		136, 137, 171, 172, 200, 202, 203, 205
	xx	in gneiss	amphibole	43, 205
	x	on talc		w
		in limestone	amphibole	43, 205
230	xx	gneiss limestone contact	apatite, wernerite	43
		"	" amphibole etc.	43
		"	"	43
	xx	"	wernerite, apatite	c
		"		43
		"		43
		"		5, 43
231	x	granite limestone contact	pyroxene	43, c
	x	"	oligoclase	43, c
	x	"	titanite	43
		"	zircon, apatite	43
	x	in limestone	calcite, pyrite	43
	x	"	fluorite	43
		"	" calcite	43
232	*†	in gneiss		149, 194
233	*†	"		194

NO.	LOCALITY	SPECIES	DESCRIPTION
	Fowler		
234	Fullerville iron works	hematite	
		quartz	pyramidal crystals
		barite	tabular crystals
235	Belmont farm	sphalerite	
		galena	
	Gouverneur		
236	4½m. n. of Gouverneur	tourmalin	brown crystals highly modified
		amphibole	short green crystals, also tremolite
		pyroxene	
		apatite	large crystals
		titanite	brilliant black crystals
		phlogopite	large sheets dark brown
		pyrite	crystallised
237	1m. s.w. of Gouver. (marble quarries)	tourmalin	plentiful brown crystals
		amphibole	tremolite
		wernerite	
		serpentine	pseudomorphs and verd antique
		fluorite	etched and twinned cubes
238	1½m. n.e. of Gouverneur	garnet	almandite
239	1m. s. of Gouverneur	orthoclase	large crystals
		pyroxene	gray and dark green
		apatite	
		vesuvianite	
		titanite	
		talc	rensselaerite
		serpentine	
		fluorite	
240	Elmdale (Smith Mills), 4½m. w. Gouverneur	amphibole	massive fibrous tremolite
		vesuvianite	
		biotite	
		graphite	
		barite	crystalline
	Hammond		
241	near De Long's mills	apatite	large crystals
		zircon	large crystals containing nucleus
		orthoclase	luxoclase, white to bluish crystals

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
234	....	limestone gneiss contact.............	quartz....................	43
	x.......	"	hematite..................	5, 43
	....	"	"	43
235	....	vein traversing serpentine............	galena....................	5, 43
	....	"	sphalerite................	43
236	xx	in Grenville limestone.............	amphibole, apatite.........	5, 43
	xx	"	apatite, tourmalin.........	5, 43
	x.......	"	"	5, 43
	x.......	"	wernerite, titanite..........	5, 43, 80
	x.......	"	tourmalin, pyroxene........	5, 43
	x.......	"	....	c
	....	"	tourmalin, calcite..........	
237	xx	"	calcite....................	5, 43, 25
	xx	"	"	5, 43
	xx	"	....	5, 43
	xx	"	calcite....................	5, 43
	x.......	"	"	43, c
238	*.......	vein in gneiss......................	quartz....................	w
239	....	limestone granite contact............	" pyroxene...........	5, 43
	x.......	"	amphibole, tourmalin.......	5, 43, 159
	....	"	pyroxene, titanite..........	43
	....	"	....	43, 79
	....	"	apatite, pyroxene..........	43
	x.......	in limestone.......................	serpentine.................	43
	....	"	talc......................	5, 43
	....	"	....	43
240	xx......	gneiss limestone contact.............	biotite, graphite...........	43, 79
	....	"	....	43
	....	"	....	43
	....	"	....	43
	....	in limestone.......................	fluorite, calcite............	79
241	xx......	in crystalline limestone..............	wernerite, titanite..........	5, 43
	xx......	"	apatite....................	5, 43
	x.......	"	" pyroxene...........	5, 43

NO.	LOCALITY	SPECIES	DESCRIPTION
	Hammond (*continued*)		
	near De Long's mills (*continued*).....	amphibole.....	pargasite and tremolite..........
		phlogopite.....	....
		pyroxene......	grayish white and green.........
		barite.........	snow white crested variety........
		pyrite.........	crystals.......................
		fluorite........	purple.........................
	Hermon		
242	Lowden mine 1m. n.e. of Hermon.....	hematite.......	....
		quartz.........	pyramidal.....................
		amphibole.....	pargasite......................
		pyroxene......	....
		tourmalin......	....
243	Dodge ore bed.....................	siderite........	bent crystals..................
		serpentine......	....
		limonite.......	bog iron ore....................
	Macomb		
244	1½m. n. Elmdale (Smiths Mills).......	fluorite........	masses of large green cubes.......
		calcite.........	Rossie type, small crystals ....
		pyrite.........	concretionary aggregates of crystals ....
245	St Lawrence Min. Co.'s mines, 1m. e. Macomb	galena.........	massive........................
		sphalerite......	....
246	1m. n.e. Macomb..................	tourmalin......	dark brown and black...........
		pyroxene......	small glassy crystals............
		amphibole.....	....
		albite..........	peristerite.....................
		graphite.......	....
		phlogopite.....	....
		wernerite......	....
		apatite........	....
247	Ingram farm......................	tourmalin......	dark brown and black...........
		graphite.......	....
248	Pope's Mills......................	phlogopite.....	....
		barite.........	....

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
	x	in crystalline limestone	apatite, pyroxene	43
	x	"	"	43
		"	zircon, orthoclase	5, 159
		"	pyrite	43
		"		43
		"		43
242	*	in gneiss		194
	x	"	hematite	5, 43
		"		43
		"		43
		"		43
243		in limestone		5, 43
		"		5, 43
		"		43
244	xx†	in crystalline limestone	calcite, pyrite	43, 116
		"	fluorite "	43, *w*
		in crystalline limestone	fluorite, calcite	*w*
245	*†	veins in limestone	calcite	43, *w*
	*†	"	galena, calcite	43, *w*
246	xx	in crystalline limestone	pyroxene, amphibole	43
	x	"	tourmalin "	159, *c*
		"	albite, pyroxene	43
	x	"	graphite "	43
	x	"	pyroxene, wernerite	43
	x	"		43
		"		43
		"		43
247	xx	gneiss limestone contact	graphite	43
		"	orthoclase	43
248	x	"		43
		"		43

NO.	LOCALITY	SPECIES	DESCRIPTION
	Morristown		
249	Mineral point, 2m. n.e. Hammond....	galena........	....
		sphalerite......	....
		fluorite........	....
		calcite.........	large clear crystals..............
	Oswegatchie		
250	Ogdensburg........................	labradorite.....	....
	Pierrepont		
251	1 m.e. West Pierrepont	tourmalin......	brilliant black crystals...........
		phlogopite.....	....
		pyroxene......	transparent, tabular crystals.....
252	farms of Wells and Vaughn...........	amphibole.....	....
		pyroxene......	....
		oligoclase......	....
253	Pierrepont.........................	wernerite......	large gray and white crystals.....
		albite	peristerite.......................
		pyroxene......	....
	Pitcairn		
254	1 m. n.e. East Pitcairn	zircon.........	fine crystals.....................
		microcline.....	white rounded crystals...........
		pyroxene.. ...	brilliant green crystals...........
		titanite........	pale red and brown crystals ......
		phlogopite.....	....
		gypsum........	satin spar.......................
255	2 m. e. East Pitcairn................	pyroxene......	large crystals....................
		titanite........	large pale red and brown crystals..
		fluorite........	....
		zircon.........	large, greenish, prismatic crystals.
		calcite........	....
	Potsdam		
256	boulder in road near Crary's Mills.....	orthoclase......	large crystals ....
		tourmalin......	black " ....
		biotite.........	....
		amphibole.....	....

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
249	....	vein in gneiss	sphalerite, calcite	5, 43
	....	"	galena	5, 43
	....	"	"	5, 43
	....	"	" sphalerite	5
250	....	in granite boulder	....	43
251	xx	limestone gneiss contact	quartz	43
	x	"	"	43
	....	"	" amphibole	43, 159
252	....	in gneiss	pyroxene, oligoclase	43
	....	"	....	43
	....	"	....	43
253	x	limestone gneiss contact	pyroxene	43, *c*
	....	"	" wernerite	43
	....	"	wernerite	43
254	xx	limestone granite contact	microcline	43
	x	"	pyroxene	43
	x	"	microcline, zircon	43
	....	"	" pyroxene	43, 223
	....	"	....	43
	....	"	....	43
255	x	granite vein	titanite, zircon	43
	x	"	zircon	43, 223
	x	"	calcite	43
	x	"	titanite, pyroxene	43
	....	"	fluorite	43
256	x	granite boulder	quartz, pyroxene	5, 43
	x	"	....	43
	x	"	....	43
	....	"	....	43

NO.	LOCALITY	SPECIES	DESCRIPTION
	Rossie		
257	Rossie lead mines 2m. s. Rossie	galena	crystallized and massive
		pyrite	crystals often highly modified
		calcite	large twinned crystals
		celestite	delicate blue
		chalcopyrite	crystals
		hematite	
		cerussite	rare
		anglesite	
		fluorite	rarely in fine octahedral crystals
258	iron mines, Somerville	hematite	laminated structure
		barite	in flattened crystals
		pyrite	crystals
		quartz	large implanted crystals
259	Somerville	spinel	rose and reddish brown
		hydrotalcite	houghite
		dolomite	
		aragonite	flos ferri
		phlogopite	in large plates
		wernerite	
260	½m. n.w. Somerville	chondrodite	yellow grains
		spinel	rose and reddish brown
		hydrotalcite	houghite
261	3m. n. Oxbow (Yellow lake)	chondrodite	yellow grains
		orthoclase	
		amphibole	bright green pargasite
		apatite	small, transparent, green crystals
		pyroxene	
		titanite	
		zircon	
		wernerite	large, light yellowish green crystals
		phlogopite	in large sheets
		gahnite	automolite
		fluorite	
		dolomite	
		graphite	
262	near Grasse lake	pyroxene	hemihedral crystals
		wernerite	greenish

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
257	x*†	vein in limestone	calcite, pyrite	5, 43, 211
	xx†	"	galena, calcite	5, 9, 43
	xx†	"	" sphalerite	5, 9, 43
	x†	"	calcite	43
		"	galena, sphalerite	5, 43
		"		43
		"	galena,	43
		"		5, 43
		"	calcite	5, 43
258	*	synclinal fold of Potsdam sandstone		194
	x	in limestone vein	quartz dolomite	43
	x	" green shale	"	5, 43
	x			5, 43
259		in limestone and serpentine	chondrodite	5, 43
		"	serpentine	43, 93, 180
		"	"	43
			dolomite etc	80
	x			43
				5, 43
260	x	in limestone	spinel	5, 43
		"	chondrodite	43
	x	"	spinel	93, 180
261		limestone gneiss contact		43
	xx	"		43
	xx	"	pyroxene, orthoclase	5, 43, *w*
	x	"	"	43, *w*
	x	"	wernerite, orthoclase	43
		"	"	43
		"		43
	xx	"	quartz, titanite etc	43, *w*
	x	"	"	43, *w*
		in limestone	dolomite	43
		"	"	43
		"		43
		"		43
262	xx	limestone gneiss contact	wernerite, titanite	43, 159, 229
	x	"	pyroxene, graphite etc	43

NO.	LOCALITY	SPECIES	DESCRIPTION
	Rossie (*continued*)		
	near Grasse lake (*continued*)	graphite	fine crystals
		orthoclase	luxoclase
		titanite	pale red and brown crystals
	Webster farm	apatite	large crystals
	"	zircon	
		amphibole	tremolite in short crystals
263	2m. n. Rossie	wernerite	greenish
		pyroxene	large green crystals
		titanite	brown crystals
		tourmalin	
		phlogopite	
	Russell		
264	Buskurk farm, 1m. n.e. Russell (?)	danburite	abundant fine crystals
		datolite	rare
		wernerite	
		pyroxene	small green crystals
		tourmalin	black
		amphibole	
		phlogopite	
		albite	
		quartz	massive and crystallized
		calcite	
265	Moore farm e. Russell	pyroxene	short, greenish black crystals
		amphibole	fine, white cryst's doubly termin'ed
		wernerite	long white prismatic crystals
		phlogopite	
266	1½m. n.w. North Russell	pyroxene	fine grayish green crystals
		phlogopite	large sheets
		apatite	crystals and massive
		calcite	pinkish massive
		molybdenite	disseminated
		titanite	black crystals
		labradorite	grayish brown massive

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
	xx	limestone gneiss contact	pyroxene, wernerite	5, 43
	xx	"	"	5, 43
	x.	"	"	5, 43
	....	"	orthoclase	*w*
	....	"	titanite etc	*w*
	....	"	....	43
263	x.......	"	pyroxene	43
	x.......	"	orthoclase, apatite	43, 159
	x.......	"	"	5, 43
	x.......	"	"	43
	x.......	"	"	*a*
264	xx	cavities and seams in gneiss	pyroxene	22, 43, 219
	....	"	"	43
	....	gneiss limestone contact	" amphibole	43
	....	"	wernerite, danburite	43
	....	"	quartz	43
	....	"	pyroxene	43
	....	"	" wernerite	43
	....	"	" quartz	43
	....	"	danburite	43
	....	"	....	43
265	xx	in gneiss	wernerite, amphibole	43, 159
	xx	"	" pyroxene	43
	x.......	"	pyroxene	43, *c*
	....	"	"	43
266	xx	gneiss limestone contact	calcite, titanite	*w*
	xx	"	pyrite inclusions	*w*
	x.......	"	calcite	*w*
	....	"	apatite, pyroxene etc	*w*
	....	"	calcite	*w*
	x.......	"	pyroxene, labradorite	*w*
	....	....	" titanite	*w*

SARATOGA

NO.	LOCALITY	SPECIES	DESCRIPTION
	Greenfield		
267	1m. n.w. Highrock spring Saratoga....	chrysoberyl....	pale yellowish green crystals .....
	in Mt McGregor ridge...............	garnet.........	pink grossularite ....
		tourmalin......	black crystals ....
		muscovite	reddish brown crystals...........
		orthoclase	transparent adularia ....
		apatite........	reddish brown crystals...........
		graphite	....

SCHENECTADY

The rocks of this county afford no recorded mineral

SCHOHARIE

NO.	LOCALITY	SPECIES	DESCRIPTION
	Carlisle		
268	2m. w. Central Bridge	calcite.........	crystallised and fibrous..........
		barite.........	fibrous ....
	Esperance		
269	Ball's cave 4m. n. of Schoharie	calcite	crystals and stalactites ....
	Middleburg		
270	4m. w. Schoharie on b'k small stream..	"	geodes lined with crystals........
271	1½m. e. of Middleburg...............	"	obtuse rhombohedrons..........
	Schoharie		
272	Schoharie e. of courthouse...........	strontianite....	columnar and granular masses ...
		celestite.......	fibrous, blue ....
		barite.........	" calcareous..............
273	2m. n.e. Schoharie..................	strontianite....	crystals in geodes...............
		barite.........	massive ....
		calcite.........	" ....
274	3m. n.e. Schoharie, near Foxes creek ..	aragonite......	radiating crystals ....
275	1m. w. of Schoharie	pyrite.........	single and twinned crystals.......
		barite	fibrous ....
276	Howes Cave	calcite.........	crystals and stalactites ....
		aragonite......	slender radiating crystals ....
		pyrite.........	nodular aggregates ....
	Sharon		
277	Sharon Springs	calcite	calcareous tufa.................

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
267	xx	in granite, traversing gneiss	quartz, tourmalin, garnet	5, 43, 210
	xx	"	" " mica	5, 43, 210
	xx	"	" garnet etc	5, 43, 210
	x	"	chrysoberyl	5, 43, 210
	x	"	" tourmalin	5, 43, 210
		"	graphite	5, 43
			apatite	43

COUNTY

localities of sufficient importance to note in this list

COUNTY

268		in Helderberg limestone	barite	43
		"	calcite	43
269		in hydraulic limestone		5, 43
270		in limestone		5
271		" veins in limestone		5
272	xx	thin veins in hydraulic limestone	barite, calcite	5,43,63,177
		"	strontianite calcite	5. 43. 63
		"		43, 63
273		in hydraulic limestone	barite, calcite	43, 63, 177
		"	strontianite calcite	43, 63
		"	pyrite	43, 63
274	x	"		63
275	xx	in blue slate		5, 43, 63
		vein in blue slate		63
276	x	in hydraulic limestone		5, 43
		"	calcite	*h*
		in shale		*w*
277		in limestone near springs		5

SCHUYLER

The rocks of this county afford no recorded mineral

SENECA

The rocks of this county afford no recorded mineral

STEUBEN

The rocks of this county afford no recorded mineral

SUFFOLK

The surface rocks of this county consist of glacial drift and afford

SULLIVAN

NO.	LOCALITY	SPECIES	DESCRIPTION
	Mamakating		
278	Wurtsboro, lead mine	galena	mainly massive
		sphalerite	
		chalcopyrite	
		pyrite	

TIOGA

The rocks of this county afford no recorded mineral

TOMPKINS

The rocks of this county afford no recorded mineral

ULSTER

NO.	LOCALITY	SPECIES	DESCRIPTION
	Kingston		
279	Rondout, cement mines	calcite	flat rhombohedrons, pyrite inclusions
		quartz	crystals showing phantom of smoky quartz
		pyrite	cubic
		marcasite	small crystals
	Marbletown		
280	High Falls	pyrite	pyritohedral crystals
	Wawarsing		
281	Ellenville, lead mine	galena	crystals rare
		chalcopyrite	" well modified
		quartz	in groups and isolated crystals
		sphalerite	massive black
		brookite	small, brilliant crystals
		pyrite	

COUNTY

localities of sufficient importance to note in this list.

COUNTY

localities of sufficient importance to note in this list.

COUNTY

localities of sufficient importance to note in this list.

COUNTY

no mineral localities of sufficient importance to note in this list.

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
278	*†	in quartzite........................	sphalerite, chalcoypyrite....	5, 43
	....	"	galena....................	5, 43
	....	"	" sphalerite..........	5, 43
	....	"	" "	5, 43

COUNTY

localities of sufficient importance to note in this list.

COUNTY

localities of sufficient importance to note in this list.

COUNTY

279	x.......	in Helderberg limestone.............	quartz......	h, p
	xx	"	calcite....................	p
	....	"	"	p
	x.......	"	"	h, w
280	....	in Helderberg limestone.............	....	5
281	*.......	vein in quartzite....................	chalcopyrite, sphalerite.....	5, 43
	xx . . .	"	quartz "	5, 43
	xx	"	chalcopyrite...............	5, 43
	....	"	galena, chalcopyrite........	5, 43
	x.......	"	quartz....................	43
	....	"	chalcopyrite...............	43

WARREN

NO.	LOCALITY	SPECIES	DESCRIPTION
	Caldwell		
282	Diamond island, Lake George	quartz	similar to Herkimer county
		calcite	white to yellow nail head crystals
		dolomite	
	Chester		
283	e. Loon lake	pyrite	crystallized
		chalcopyrite	imperfect crystals
		rutile	
		tourmalin	
	Hague		
284	Sabbath Day Point	epidote	common massive
		wernerite	
		titanite	
285	Graphite 4m. w. Hague	graphite	leafy masses
		apatite	small crystals
		garnet	large red crystals
	Johnsburg		
286	Moore's mine, Gore mountain	garnet	massive
		pyroxene	coccolite
287	North River Garnet Co.'s m., Oven mt.	garnet	massive
		pyroxene	coccolite
	Queensbury		
288	Glens Falls	calcite	crystals of lenticular form
		dolomite	well defined crystals
	Thurman		
289	Thurman	fluorite	
		zircon	large and interesting crystals
		graphite	irregular shaped masses
		serpentine	yellowish green
		pyrite	fine crystals
		garnet	almondite
	Warrensburg		
290	Warrensburg iron mine	magnetite	

WASHINGTON

NO.	LOCALITY	SPECIES	DESCRIPTION
	Fort Ann		
291	1m. n. Fort Ann	graphite	
		pyroxene	
		quartz	
292	Shelving Rock	serpentine	yellowish green, translucent

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
282	x	Beekmantown limestone	calcite	5, 43
	x	"	quartz	43
		"	"	5
283	x	crystalline limestone	tourmalin, rutile	5, 43
		"	"	43
		"		5, 43
		"		5, 43
284		in gneiss		5
		"	titanite	f
		"	wernerite	f
285	*	quartzite and limestone	quartz	111
		"	zircon	111
		in gneiss	sillimanite	111
286	*	in hornblende schist	pyroxene	112, e
		"	garnet	w
287	*	"	pyroxene	112, e
		"	garnet	w
288		in Trenton limestone	dolomite	5
		"	calcite	5, 43
289	xx	crystalline limestone	pyrite etc.	5, 43
	xx	in quartz vein	graphite	5, 9, 43
	x	"	zircon, garnet	5
	x	crystalline limestone		5, 43, 132
	x	"		5, 43
		in quartz vein		e
290	*†			194

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
291	x	gneiss limestone contact	pyroxene, quartz	5, 43
		"	quartz	5
		"	graphite	5
292	x	crystalline limestone		5

WASHINGTON

NO.	LOCALITY	SPECIES	DESCRIPTION
	Granville		
293	....	pyroxene......	lamellar........................
		orthoclase......	massive........................
		epidote........	....
294	Middle Granville....................	pyrolusite......	dendrites........................
	Putnam		
295	Anthony's Nose....................	hematite.......	mammillary, botryoidal..........

WAYNE

NO.	LOCALITY	SPECIES	DESCRIPTION
	Wolcott		
296	Wolcott mine......................	hematite.......	fossil ore........................
		barite.........	pinkish crystals, highly modified..
297	Ontario mines......................	hematite.......	oolitic ore........................

WESTCHESTER

NO.	LOCALITY	SPECIES	DESCRIPTION
	Cortlandt		
298	Anthony's nose 4m. n.w. Peekskill on northern side of mountain..........	pyrrhotite......	massive........................
		chalcopyrite....	" ....
		magnetite......	sparingly disseminated...........
		pyroxene......	....
		amphibole.....	....
		apatite........	small green crystals.............
		calcite.........	tabular crystals coated with quartz
299	Crugers..........................	pyroxene......	white..........................
		amphibole.....	....
		staurolite......	minute crystals.................
		cyanite........	....
		sillimanite.....	fibrolite........................
300	emery mines between Crugers and Peekskill........................	corundum.....	emery, intimately mixed with magnetite ....
		magnetite......	intimately mixed with emery.....
		spinel.........	hercynite........................
		garnet.........	small rounded crystals...........
301	south side of Verplanck Point........	chrysolite.....	....
		garnet.........	....
		staurolite......	....
		amphibole.....	gray green actinolite............
		pyroxene......	....

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
293	x		orthoclase, epidote	43
				43
				43
294		in Georgia quartzite and slates		43
295		in gneiss		27, 111

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
296	*†	Clinton formation		194
		"	hematite	43
297	*	"		194

COUNTY

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
298	*†	in gneiss	chalcopyrite	5, 43, 101
		"	pyrrhotite	43, 101
		"	"	43
		"	amphibole, calcite	43
		"	pyroxene	43
		"	chalcopyrite	43, [illegible]
	x	"		43
299		in norite contact	amphibole	43, 228
		"	pyroxene	42
		"	sillimanite	43, 228
		"	"	228
		"	staurolite	43, 228
300	*	in norite	spinel garnet	43, 228
	*	"	"	43, 228
		"	magnetite	43
		"	"	228, [illegible]
301		in norite contact		44
		" mica schist	staurolite	44
		"	garnet	44
		in limestone	pyroxene	44, 228
		"	amphibole	228

WESTCHESTER

NO.	LOCALITY	SPECIES	DESCRIPTION
	Cortlandt (*continued*)		
302	Peekskill	amphibole	
		staurolite	small crystals
		graphite	
	Eastchester		
303	Tuckahoe	dolomite	massive
		phlogopite	
		sphalerite	dark rounded masses
		pyrite	
		chalcopyrite	
	Harrison		
304	1m. w. Port Chester	serpentine	pinkish brown masses
		brucite	
		chlorite	
		tourmalin	black
		amphibole	tremolite
	Mt Pleasant		
305	Pleasantville	muscovite	large sheets, magnetite inclusions.
	New Rochelle		
306	New Rochelle, Davenport's neck	serpentine	yellow, green and pinkish
		magnesite	snow white crusts
		brucite	small, imperfect crystals
		amphibole	actinolite, tremolite and hornblende
		enstatite	bronzite
		chromite	disseminated crystals and grains.
		quartz	drusy crystals and chalcedony
		garnet	small, imperfect crystals
		titanite	
		deweylite	
		calcite	crystalline massive
	Ossining		
307	Ossining, Prison quarry	pyroxene	malacolite
		amphibole	tremolite
		pyrite	small bright crystals
		graphite	crystals

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
302	....	in norite........	....	43
	....	in mica schist........	....	43, 223
	....	"	....	43
303	*.......	dolomitic limestone........	pyrite, chalcopyrite........	5, 43
	....	"	....	*m*
	....	"	pyrite, chalcopyrite........	43
	....	"	dolomite........	43
	....	"	"	43
304	....	mica schist........	brucite etc........	5, 43
	....	in serpentine........	serpentine........	*m*
	....	"	amphibole........	5, 43
	....	in mica schist........	....	5, 43
	....	" serpentine........	brucite etc........	5, 43
305	x	....	....	*e*
306	....	neighboring rock mica schist........	brucite, chromite........	5, 43, 129
	....	on serpentine........	serpentine, brucite........	5, 43
	....	"	" etc........	5, 43
	....	serpentine........	enstatite, garnet........	5, 43, 129
	....	"	amphibole........	43, 129
	....	"	serpentine........	5, 43
	....	vein in serpentine........	deweylite........	5, 43, 129
	....	in mica schist and hornblende rock....	titanite........	5, 43
	....	"	garnet........	43
	....	vein in serpentine........	chalcedony........	129
	....	"	"	129
307	x.......	in dolomitic limestone........	amphibole........	5, 43
	x.......	"	pyroxene, pyrite........	43
	x.......	"	amphibole........	43
	x.......	"	calcite........	*e*

NO.	LOCALITY	SPECIES	DESCRIPTION
	Ossining (*continued*)		
	Ossining, Prison quarry (*continued*)...	quartz	chalcedony incrusting dolomite crystals......................
		"	crystals, occasionally doubly terminated.....................
		dolomite.......	crystals ....
		talc	green foliated ....
		rutile..........	slender prismatic crystals........
		serpentine	pseudomorph after pyroxene .....
		calcite........	scalenohedral crystals...........
308	Sparta, 1 m. s. Ossining (old copper mine)	cerussite.......	small prismatic crystals..........
		pyromorphite ..	mammillary incrustations on galena.......................
		anglesite......	....
		vauquelinite...	green and brownish concretions...
		wulfenite......	sparingly in tabular crystals .....
		vanadinite	....
		galena.........	....
		chalcopyrite ...	in minute crystals and massive ...
		azurite........	....
		malachite......	....
		pyrite.........	small crystals ....
		calcite.........	crystals of prismatic habit ....
309	Shafts 3 and 4 New Croton aqueduct 4m. s.e. Croton Landing...........	stilbite.........	radiated aggregates..............
310	Shaft 5 New Croton aqueduct, Whitson	rutile..........	....
		harmotome.....	twin crystals lining vugs.........
		heulandite.....	....
		stilbite........	small, sheaflike aggregates........
		pectolite.......	....
		beryl..........	....
		pyrite.........	small bright crystals.............
		barite.........	white crystals and masses........
		quartz.........	rough, imperfect crystals.........
		calcite.........	modified crystals, P't Henry type
		chrysolite......	yellow grains...................
		tourmalin......	minute, transparent, yellow prisms

COUNTY *(continued)*

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
	x	in dolomitic limestone	dolomite	*e*
	xx	"	"	*e*
		"	talc, mica	*e*
		"	dolomite	*e*
		"	" quartz	*e*
	xx	"	pyrite	c
	x	"	dolomite	*e*
308		"	galena, chalcopyrite	5, 43
		in dolomitic limestone	galena, chalcopyrite	5, 43
		"		43
		"	pyromorphite	5, 43
		"	vanadinite, pyromorphite	43
		"	wulfenite	43
		"	chalcopyrite, cerussite	43
		"	galena	5, 43
		"	malachite, galena	5, 43
		"	azurite, galena	5, 43
		in gneiss	calcite	*e*
		on mica schist		*e*
309		on gneiss	calcite, pyrite	*e*
310		in "		43, *e*
	xx	"	pyrite, barite	43, *e*
	x	"	"	43
		"		43, *e*
		"		43
		"		5, 43
		"	calcite	*e*
		"	"	*e*
		"	"	*e*
		"	pyrite	*e*
		"	prochlorite, tourmalin	*e*
		"	chrysolite	*e*

WESTCHESTER

NO.	LOCALITY	SPECIES	DESCRIPTION
	Yonkers		
311	2½m. n. Yonkers on aqueduct.........	pyrite.........	....
		calcite.........	....
		amphibole.....	tremolite in radiated aggregates...
		garnet.........	small, rounded crystals & masses..
		tourmalin......	black crystals seldom perfect.....
		stilbite........	....
		muscovite......	rhombic prisms..................
		apatite........	transparent crystals..............
		epidote........	massive and crystals..............
		analcite........	small, perfect crystals............
	Yorktown		
312	Croton Lake.......................	sillimanite.....	fibrolite.........................
		monasite.......	good crystals....................

WYOMING

Salt is obtained in commercial quan-

YATES

The rocks of this county afford no recorded minera

COUNTY (*continued*)

NO.	QUALITY	GEOLOGIC ASSOCIATION	MINERALOGIC ASSOCIATION	AUTHORITY
311	x	in gneiss		43
		"	amphibole	43
		"	calcite, muscovite	5, 43
		"	tourmalin	5, 43
		"	apatite, garnet	5, 43
		"	calcite	5
		"	amphibole	5, 43
		"	epidote	5, 43, 115
		"	apatite	115
		"	tourmalin etc	5, 43
312		in mica schist	monasite, amphibole	43
		"	sillimanite	43

COUNTY

tities from the rocks of this county.

COUNTY

localities of sufficient importance to note in this list.

CORRELATION LIST ARRANGED ACCORDING TO SPECIES

The numbers refer to the numbered localities given in columns 1 and 5 of the preceding list.

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New York State Museum

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FREDERICK J. H MERRILL Director

Bulletin 71

ZOOLOGY 10

FEEDING HABITS AND GROWTH OF VENUS MERCENARIA

BY

JAMES L. KELLOGG Ph. D.

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Bulletin 71

ZOOLOGY 10

FEEDING HABITS AND GROWTH OF VENUS MERCENARIA

Introduction

In a previous bulletin of the New York State Museum,[1] attention was directed to the fact that both the hard clam, or little-neck, and the common long-neck clam were rapidly diminishing in numbers, not only in the waters of New York State, but also along the entire Atlantic coast where these forms have previously been found. After a careful examination of a large part of the coast of New England and Long Island, it appeared that the apprehensions of many market men and clammers concerning the growing scarcity of these forms were well founded. It was not intended that the attitude of an alarmist should be assumed. Clams still may be had at almost any hotel or restaurant. Even if the natural beds alone are depended on, as heretofore, a certain supply may be had for some time. But it is certainly true that, unless something is done to check or modify the indiscriminate and unintelligent methods of taking these forms now in vogue, the supply is finally to fail more or less completely everywhere, as it has already failed in many localities. That time is not remote. It is difficult for one not personally familiar with the clam flats and beaches, and their histories, to realize the truth of such a statement. While at any time one may obtain fresh or canned lobsters in the market, it is difficult to interest him by the statement that he may not long be able to

1 Clam and Scallop Industries of New York State. N. Y. State Mus. Bul. 43.

indulge his taste for them; yet even now lobsters are dangerously near extinction on our coast. But it is the consumer who should be interested, if possible, because from him, through his representatives in the Legislature, must come the action which shall make possible new and intelligent methods of propagation which may preserve the supply.

Unpleasant facts of this kind, in any case, should be considered seriously by the public-spirited citizen; but his interest would be enlisted, and his support obtained much more readily, if he could be shown some practical way out of the difficulty.

It has been proved, I think beyond question, that, not only are methods of cultivating the common clam, *Mya arenaria*, easy and inexpensive, but the results of the labor involved are astonishingly great. "Seed" clams may readily be obtained in many localities. They may, when necessary, be transported from one place to another without injury. The planting is a simple process. Small individuals may even be sown broadcast on a soft bottom like so much grain. Unlike the oyster, the salinity of the water makes little difference with their growth. Most important of all, their growth is extremely rapid.

This method of culture, the details of which have been carefully worked out and tested in artificial beds, was developed after a study of the life history, the habits, and the conditions of growth. Everything of scientific interest concerning the form has not been investigated. The early stages of development from the egg, for example, are not yet known; but enough was known to devise an entirely satisfactory and practical method of culture, and this method has been thoroughly tested.

The question may be asked, why, if the demand is increasing and prices are rising, if the supply has everywhere fallen off, and if a cheap and practical method of culture has been devised, do not those who are interested in supplying the market become clam "farmers," instead of remaining clam-diggers?

The answer is that ancient laws still leave beaches and flats to the people. They are public grounds where all have equal rights. On them any one may dig at any time. No man has a right to plant and protect his clams, and clam culture is impossible. To

repeal a law of this character is extremely difficult, for it appeals to the many as a cession of their rights to the privileged few. But all would have equal rights to the property by lease or purchase. Good beaches are very numerous, and there is little danger that any would be excluded who might desire such property. The sale and lease of bottoms to oystermen along the shores of Long Island, have apparently worked injustice to no person who is desirous of entering that occupation. At a very few points on the coast, portions of flats have been leased to clammers. These experiments have failed because of a lack of adequate protection. Unless such a system, with proper protection, is introduced by the repeal of old, and the enactment of new laws, soft clam culture will be impossible, and such laws can be had only when they are desired by the people at large.

The little-neck clam, *Venus mercenaria*, grows most abundantly below the low tide line, where it is taken by means of tongs. Much of the shallow bottom about Long Island, in which clams were formerly taken, has been leased to oystermen. The profit from oyster culture is much greater, acre for acre, than that derived from the taking of hard clams, which are left to propagate by the natural method. The areas left to clammers are now limited, and the greater part of the supply used in the canning industry comes from the southern coast. At the same time, clams are rapidly diminishing in the available beds.

The little-neck is also found between tide lines. This fact suggested experiments to determine whether they grow well in such places. Beaches and flats are not now generally available by lease. If this were given, these areas could be more easily protected than those in deeper water, and the matter of planting and digging would be greatly simplified. It is of the utmost importance, however, that clams not continually submerged should increase in size with some degree of rapidity, to insure the success of culture methods under these conditions. An account will be given of this growth in Venus.

Very little is known of the growth of lower organisms. Among the Lamellibranchiata, the group of mollusks to which the clams belong, much is known concerning the growth of the oyster, which, for many years, has been artificially reared in Europe and

America. But, till very recently, no observations have been made on the growth of any clam. In work for the United States Fish Commission, the results of which have not yet been published, Mya was reared in many places, the experiments being carried out on a large scale. In many ways the results were astonishing, particularly in regard to the rapidity of growth. Not only was the actual amount of growth observed, but also the conditions under which it was least and most rapid, or altogether impossible. It was my desire to continue the same line of work with Venus, as nothing was known concerning its growth or the conditions governing it. Though from lack of time and facilities, these experiments were not extensive, they were most encouraging, and show that this form also increases in size rapidly, even when exposed at low tide.

Feeding habits of Venus. Growth a matter of food

Within wide limits, rapidity of growth in clams seems to depend directly on the amount of food. In order to make clear the conditions under which rapid growth is possible, the feeding habits of Venus should be described.

Before such a description is possible, some anatomical features must be noticed. In a clam bed, the animal lies but a short distance below the surface of the bottom. Though the shell is entirely hidden, the creature reaches up to the water above by means of a fleshy extension of the body, which has the form of a double tube. These tubes are known as the siphons, and may quickly be retracted within the valves of the shell. On a smooth bottom, the ends of the siphons may be seen, when the animal is undisturbed, extending out to the level of the surface. A close inspection will show that a steady stream of water is entering one tube [fig. 1, *in. s*] and leaving the other [*ex. s*]. The margin of the first tube is crowned by short, tactile tentacles. When touched by foreign bodies floating in the water, these sense organs cause a closing of the incurrent siphon, or perhaps a retraction of the entire structure. The microscopic diatoms, which form the food of clams, are so small and so evenly diffused in the currents, that they do not induce these movements.

When the animal is removed from the bed, the tight fitting valves of the shell are found to be firmly closed. It may be necessary to break the shell in order to insert a knife blade by means of which the two powerful muscles which connect the valves, and by their strong contraction close them, may be cut. Removing one half of the shell, it is seen that both shell valves are lined on their inner surfaces by thin, fleshy flaps which grow out from the sides of the body. These are known as the mantle folds [*fig.* 1, *m*], and they inclose a large space, the mantle or branchial chamber, in which is found the main part of the body. The body, however, does not entirely fill the mantle chamber, but a large space remains which is filled with water. The siphons are seen to be simply a modified portion of the mantle. It is into this space that the inflowing stream of water, bearing the microscopic food, must enter. The manner in which the food is collected and passed into the mouth will be described presently. While the mantle folds are free at their margins, their edges are closely applied to each other, and the mantle chamber is essentially a closed space, excepting for the siphonal openings.

If now one of these mantle folds be cut away, the body is exposed from the side and appears as represented in figure 1. The mantle fold on the farther side is shown at *m*, lining the entire inner surface of the shell valve, *s*.

Two large, conspicuous folds, *ig* and *og*, the gills, arising from the side of the body, hang free in the mantle chamber. In this position, they are continually bathed by the incoming stream of water, and they perform a very important function in addition to that of the aeration of the blood — that of food collection. Just anterior to the gills, and behind the large anterior adductor muscle, *aa*, are two small folds, *ap* and *pp*, the labial palps. The portion of the palp seen in the figure, *ap*, is simply the lateral extension of a fold which hangs in front of the mouth like a huge lip drawn out to a point on the sides. The posterior palp is similarly placed behind the mouth. The mouth opening is on the median line behind the anterior adductor muscle, and is hidden from view by the closely applied palps. It is a funnellike entrance to the digestive tract, and, because the food of the clam is microscopi-

cally small, it is supplied with no special organs such as teeth or rasping structures.

I would call particular attention to the relation in position between these palps and the anterior edges of the gills; for I wish presently to describe the manner in which food is transferred from gills to palps, and by these into the mouth.

When the gills are removed, there is exposed the main mass of the body [*vm*, fig. 2] which is made up chiefly of a large colored gland, the function of which is the secretion of the digestive fluid, and the greatly developed sexual glands. This body in anatomical descriptions, is called the visceral mass, to distinguish it from the muscular organ which is developed on its under or ventral surface — the so called foot, *f*. The last named organ is represented in the figure as being contracted within the mantle chamber. It is capable of great distension and, in a large clam, may be projected for a distance of two or three inches from the edges of the shell. Though a fleshy structure, it is, when protruded, quite tough and firm, being made rigid by a large quantity of blood which is pumped into it by the heart, in order to cause its distension. The foot is an organ of locomotion, and is also used in burrowing. It is possible for Venus to creep about by means of its thrusting and wormlike movements; but I believe that the animal uses it in this way much less than is generally supposed, and this is a point of much interest to the clam culturist.

In order to understand the mechanism by means of which food is collected, it is necessary to describe in more detail the structure of gills and palps. The gills are the most complicated organs in the bodies of lamellibranchs, and must be described here as briefly and as simply as possible, without mentioning their wonderful histological structure. Outer and inner gills are practically the same. Suppose that one of these is carefully removed from its line of attachment to the body, and studied by means of the microscope from the surface and in section: such an examination shows the gill to be not a solid flap or fold, but an exquisitely minute basketlike structure with an outer and inner wall inclosing a space between. These walls are made

of extremely fine rods placed side by side, as represented in the most diagrammatic way possible in figure 3. In order that these rods, *r*, may retain their position, they are in many forms, irregularly fused with each other by secondary lateral growths of tissue, *ic*. The outer and inner walls of the gill are also held together by partitions which extend across the inner space between them, *p*. The gill is thus seen to be basketlike, the walls being made of rods between which are spaces, *s*, which put the interior chamber in communication with the mantle space in which the gills hang.

These rods, or filaments, of which the gill is made, contain an interior space in which the blood flows. They were probably primarily developed in order that the blood of the body might be brought in close contact with the water, that, by diffusion, the carbon dioxid of the blood might pass outward through the thin walls, while, by the same process, oxygen, carried by the water, might pass into the blood. But, in addition to performing the function of breathing, the gills have taken on that of collecting minute organisms used as food. This is accomplished by a complicated process.

We have seen that a constant stream of water entered the mantle or branchial chamber. What becomes of it? And what is it that causes the current? All of this water in the mantle chamber streams through the minute openings between the filaments of the gill and enters its interior space. It now rises to the base of the gill, and flows into a tube, the epibranchial chamber [*fig*. 1, *ec*], through which it passes backward, leaving the body by the upper or exhalent siphon, which is directly continuous with the epibranchial chambers of the four gills. The currents which we first noticed, then, enter the mantle chamber by the lower siphon, pass into the interiors of the four gills, flow to their upper or attached edges, and are directed backward and out through the upper siphon tubes of the mantle.

The cause of these rapid currents is revealed by a microscopic examination of the rods or filaments of the gills. These are found to be covered on their outer surfaces, which face the water on both sides of the gill, with innumerable short, hairlike structures which project perpendicularly from the surface. These cilia

are protrusions of the living protoplasm of the cells which form the walls of the filaments. Each possesses the power of movement, lashing in a definite direction, and recovering the original perpendicular position more slowly. This movement is so rapid that it can not be seen till nearly stopped by inducing the gradual death of the protoplasm. It is very effective in causing strong currents in the surrounding water.

A microscopic examination, and direct experiment with minute, floating particles, will show that other cilia are present on the filaments than those which cause the water to enter the gills. The diagrammatic figure of the gill [fig. 3] does not show why the minute food particles may not be taken into the interior of the gill by the entering stream of water, and finally out of the body through the broad water channels. This is prevented by long cilia arranged in bands which project out laterally between contiguous filaments in such a way as to *strain* the water which enters the gill, thus preventing all floating matter from entering. These highly specialized cilia tracts of lamellibranch gills, I have called the "straining lines."[1] In some forms there is a single line, in others there are two. In some cases the lines are formed by a single row of cells; or a section across the line sometimes reveals several closely crowded cells bearing the greatly elongated straining cilia.

That foreign matter is really excluded as the current of water enters the gill, may be demonstrated by direct experiment on a living gill. Carmine may be ground into a fine powder, and suspended in water without becoming dissolved. If a small amount of this is allowed to fall on the surface of a living gill, it will be seen to lodge there. A wonderful thing now occurs. A myriad of separate minute grains, which may represent the food of the clam, are almost instantly cemented together by a sticky mucus which is secreted by many special gland cells in the filaments, and the whole mass, impelled by the oscillations of the cilia, begins to move with some velocity toward the lower or free edge of the gill. On this free margin is a groove into which the material collected on the faces of the gill is turned.

1 Kellogg, J. L. Contribution to Our Knowledge of Morphology of Lamellibranchiate Mollusks. U. S. Fish Com. Bul. 1892.

This groove is also lined by ciliated cells, and the whole mass is swept swiftly forward in it toward the palps. The natural food of the clam, of course, is carried forward in the same way. It is evident that a large proportion of the organisms floating in the water which enters the mantle chamber must come in contact with the sides of the gills, and be carried forward to the mouth folds, to which they may be transferred.

These points may be made more clear by referring to the diagram [fig. 4]. It represents a section made transversely across the filaments of a typical lamellibranch gill. In a single gill there are thousands of these rods. But five are shown here on each side, standing in row to form the perforated walls of the gill. Each rod is represented as being more or less oval, when its cut end is viewed in this way. In three places are shown the lateral union of filaments. The reference letters *ig* are supposed to be placed in the interior space of the gill, and *p* shows the nature of the partition, or septum, which, at more or less regular intervals, stretches across this space and holds the two walls of the gill together.

The details of cellular structure have been drawn in two filaments. The long, straining cilia, which stretch across the spaces between rods, are shown at *sc*, and the arrow indicates the course taken by the water current as it enters the interior of the gill. The cilia which cause this entering current are the frontal cilia, *fc*. Opening on the surface between them and the straining cilia are the gland cells, *gc*, the secretion from which cements together the food particles.

This figure is not intended to represent the details of structure found in the gill of Venus, which is much more complicated in many ways. The general plan of structure and of function in that form, however, is very much as represented, and this diagram is used because it may be so much more easily described.

If we now examine the palps with a hand lens, we may notice that their inner surfaces — those nearest to the mouth — are covered by a set of very fine parallel ridges. The lateral portions of the palps are shown in figure 2, *ap* and *pp*. They are capable of many movements. They may be bent and spirally twisted,

lengthened or shortened, and, if their inner faces touch the edges of the gills, any material which is being brought to this region is transferred onto the ridges of the palp. This is accomplished by strong cilia which are developed on the ridges. These same cilia carry the foreign matter on across the ridges, and finally force it into the mouth [arrow on *pp*].

This, in brief, is the method by which clams and oysters and other lamellibranchs collect and ingest their food. The process, till very recently, has not been closely studied, but this automatic feeding process has been known in a general way for a long time. It has sometimes been said that, if a lamellibranch is to prevent suspended mud from being collected by the gills, it must close its shell, thus entirely preventing all ingress of water into the body. It has been found that these creatures have no more control over the activities of the cilia which have been described than a man has over the cilia in his trachea. As long as the animals live, the cilia continue to lash in the same definite directions, though their activities soon become lessened after the shell is removed.

But I have found that the animal can prevent food or particles of dirt from being taken to the mouth while the stream of water is yet flowing. It seems never to have been suspected that complicated mechanisms existed, by means of which collected particles could at once be discharged from the body. They are present, however, probably in all lamellibranchs, differing somewhat in different forms, and I shall describe the comparatively simple one which is found in Venus.

If the mantle and gills are removed from one side of the body, so as to expose the visceral mass and the foot, and the creature is put into a dish of sea water, grains of carmine, which are allowed to settle on the surface of the visceral mass, at once indicate the presence of a ciliation there, as well as on palps and gills. These experiments require care and patience, but they show with great certainty that the most definite cilia currents exist in this region. These are indicated by the arrows placed on the visceral mass in figure 2. It will be seen that all the currents converge at a definite point, *x*, just above the line of the base of the muscular foot on the

posterior margin of the visceral mass. Any material, then, which touches this surface, instead of being taken toward the mouth, tends to be forced in the opposite direction. Immediately on touching the wall of the visceral mass, the fine particles are cemented together by an abundant mucus, as on the gills. When much carmine or mud is used, a large ball of it is collected at *x*. It will be noticed that this region lies directly in the path of the incoming stream of water from the branchial or lower siphon; and at first sight it would seem that from this position there could be no means by which it could escape from the mantle chamber. Clams undisturbed in the bottom, however, from time to time may be seen to discharge a strong jet of water from both siphons. This habit of many lamellibranchs is better shown in Mya. When these clams are kept in a bucket of water over night, the floor will be wet for many feet around it in the morning, and indeed one may at any time when they are so kept, see them violently close the shell by contracting the adductor muscles, thus emptying the mantle chamber by throwing a strong jet out of both siphons. This peculiar habit of all lamellibranchs which have been observed is, without doubt, for the purpose of removing masses of material which the animal can not use as food.

This is not the only means of discharging undesirable material from the mantle chamber. If the entire body be removed, leaving only the mantle lining the shell on one side, it also will be found to be ciliated. In this case, as illustrated in figure 5, everything is swept downward toward the free edge of the mantle, and falls into a line parallel with the edge, and is then directed backward. Particles which may fall on the extreme edge are also passed into this well marked stream. Everything is directed backward, but can not be carried out of the incurrent siphon against the stream which is entering through it. In a little bay beneath the base of the siphon, where it is out of the current, the material is collected. By the contraction of the adductor muscles, and the resulting emptying of the mantle chamber, as described above, this collected mass is expelled.

But, in spite of the activities of these two surfaces, which tend to rid the body of material not fit for food, it is evident that, if

much mud is entering, large quantities of it must be collected on the gills and be sent forward toward the mouth. I have spoken of the fact that the palps are capable of extended movements. If they are withdrawn so as not to touch the gills, material will accumulate in the anterior parts of the gill grooves till masses are formed so large that they fall off into the space of the mantle chamber below — perhaps to be taken up by the currents on the mantle. At any rate, they would be discharged when the mantle space was emptied. I have no doubt, especially after what I have observed in forms like Yoldia, that the palps of Venus are from time to time withdrawn from contact with the gills, in order that they may receive no material from them.

It is when we come to examine the palps that we find the most complex arrangement for keeping material from entering the mouth when that is desirable. A close examination of the inner faces of the palp shows a narrow strip around its margin which is without the ridges previously described. Both of these margins are very densely ciliated. When suspended material falls on the upper margin, it is carried up onto the surface of the ridges [fig. 2, *um*] and across them to the mouth. Anything which touches the other margin, on the other hand, is swept with great rapidity in the other direction — out to the end of the palp, where it accumulates and is finally thrown off into the mantle chamber below. It is true that this margin is narrow, and not much material suspended in the water would strike it; but probably when a large quantity is collected on other parts of the palp, this edge is folded over so as to touch these heavily laden surfaces, and sweeps them clean.

It thus appears that there are extensive ciliary tracts for collecting and conveying food to the mouth; but that, in addition to these, there are other ciliated surfaces by means of which undesirable material may be excluded without the necessity of closing the shell. Because of the advantage of sustaining the aeration of the blood, this must be of very great service when the water is muddy.

In this description of the feeding habits of Venus many important details have been omitted, particularly in regard to the

anatomy of the gill, which is much more complicated than is indicated in the figures.

The question of food is an important one when we are searching for means of rearing this clam by some culture method. In order to force the growth of oysters in French *claires*, water is held in reservoirs back of the beds till the contained diatoms may have multiplied greatly, and is then allowed to run over the beds. Such methods are expensive, and under proper natural conditions, Venus will grow very much faster than either the European or American oyster. Enough has been said of the food of Venus to make it clear that, if it were raised on beaches or flats, we should not expect to find so rapid a growth as if it were never exposed, for feeding is impossible without water currents. I hope to show, however, that growth seems to be very rapid even under these circumstances.

Growth experiments

Before speaking of these experiments, it will be well to make it clear that the planting was done on a small scale, and was pursued under the most adverse circumstances. I believe that the results as we have them are perfectly certain — and they are most satisfactory as they are; but I am also sure that under favorable conditions growth would have been very much greater.

A trip was made to Riverhead, and the shore examined carefully as far as Greenport. Many clams are found along this shore, and several sites were located, which, so far as currents and character of bottom were concerned, seemed to be ideal. In every case, however, I was assured that clams would not be allowed to remain unmolested for a week. So certain did this seem, that the very much less favorable harbor at Cold Spring, on the sound, was selected. Here also it appeared that no portion of any of the beaches would be free from molestation by clam-diggers. The only thing to be done was to ask the privilege of a small space on an oyster bed which extended close to the low water mark. This was granted by Captain Jones, who has my sincere thanks for this favor, and also for the kindly interest which he showed in the work.

The rights of the oystermen seem to be strictly respected. I ventured to run some of my beds up on the narrow beach nearly

to the high tide line, marking them by labeled wires which were run down out of sight. These I easily found in the winter, but some of the beds had been raked clean. Others certainly escaped observation. Before planting, the ground was raked, that I might be assured that no little-neck clams were present in it. I am very positive that the beds and sealed wire cages on the oyster ground had not been touched when they were examined after an interval of six months.

But the unfavorable conditions were these. Everywhere above and below these beds, oysters covered the bottoms as close as they could lie. They take from the water the same floating organisms which Venus uses for its food. Everywhere, too, above and below low tide line, soft clams were burrowed almost as close as they could be placed. They also use the same food. Now, we have experimental evidence to show that the growth of all these forms is, up to a certain point, directly proportionate to the amount of food. They all grew here; for, on account of the conditions of the upper harbor, where at high tide the shallow water, fed by fresh-water streams, was warmed for hours by the sun, diatoms must have multiplied with great rapidity, and, when carried out, offered abundant food. But undoubtedly none of these lamellibranchs grew as they would if the life of the bottom had not been so abundant.

As an example of the number of these organisms on the bottom, this case may be cited. A flowerpot, 4 inches across the top, filled with clean sand, was sunk nearly to the level of the ground on June 19, 1901. In it was placed a little-neck clam. When examined Dec. 28 of the same year—six months afterward—the sand in this pot contained 11 soft-shelled clams ranging from half to three quarters of an inch in length, besides the hard clam, which had increased considerably in size. These soft clams had settled in the pot from the swimming larval condition, as they settled elsewhere on the bottom, and had begun to grow. It is most reasonable to suppose that, if this hard clam had been growing on almost any beach where less life was being supported, its growth would have been more rapid, for diatoms are more or less abundant all along the shore.

Another serious hindrance to the growth of clams is the presence of the seaweeds, Ulva (sea lettuce) and Enteromorpha which, during the greater part of the year, grow profusely after their attachment to large pebbles or other solid bodies on the bottom. Not only the larger stones on these beds, but, especially, the wire cages which were sunk into the bottom, were in December more or less completely covered by them. In extended experiments on the growth of the soft clam, Mya, the same difficulty was met with in many localities. The masses of weed, flattened out on the bottom by the tide currents, greatly hinder the clams underneath from obtaining from the water their needed food. My experiments with both forms show that this condition is detrimental to the best results. If one were free to select sandy ground which would afford no means of attachment, this difficulty would not appear.

These matters are spoken of in detail because the results which will be given should, without doubt, have been far greater. Any one with rights to certain parts of a beach, who could watch his beds at all times of the year, could, with very little labor, prevent these drawbacks.

Still another difficulty attending the work at Cold Spring was the fact that it was almost impossible to obtain clams small enough for planting. None were to be had in this locality. A number were sent from Jamesport, L. I., but most of them were of marketable size, and hence too large for the most important part of the experiment. The smaller ones came from New Bedford Mass., and these had perhaps previously been received from Edgartown. It must however be said that the hard clam, like the oyster and quite unlike the soft clam, Mya, will live for many days, and even for weeks, after being removed from the water during the hot summer time, without apparent injury. The soft clam may be preserved in this way for a long time during the winter, and very small individuals may safely stand much exposure in hot weather; but the larger forms of this species succumb after a short time. The tenacity of life in the small Venus may also be greater than in the adult, but nothing is known in regard to it.

Methods

Each clam was measured in sixteenths of an inch at the time of planting, and also when taken from the bottom six months afterward. Merely to state the increase in length, however, gives no adequate idea of the actual growth. It is much better to give the increase in volume. To state that a clam increases from $1\frac{2}{16}$ to $1\frac{12}{16}$ inches in a certain time gives little idea of its actual growth. If individuals of the two sizes are held in the hand and compared by the eye, the bulk of one is seen to be much greater than that of the other. It is really this increase in volume which we wish to determine, so each clam was measured also by determining its displacement in water. A table was made showing the displacement of clams of various sizes. For example, many individuals just 1 inch in length were measured in a graduated vessel. There is some slight variation, because some are thicker than others. The average of many measurements, however, show that a clam of this length displaces 2.5 c.cm. The average displacement of other sizes was determined in the same way.

To illustrate the difference in the two ways of stating the increase, we may compare clams 1 and 2 inches in length. One is 100% longer than the other. One has a volume of 2.5 c.cm, the other a volume of 22 c.cm; and, while a clam 1 inch long has increased in length 100%, it has increased in bulk or volume 780%. This increase in size or volume is what we wish to determine.

Suppose that in a certain bed are placed clams all of a size. When these are dug, after a lapse of several months, some individuals will have increased in size more than others, though the differences may not be great. In order to determine the increase in such a bed, the arithmetical mean length of the whole series has been calculated, and the volume of the mean has been compared with the volume of the clams when planted.

In one bed, for example, several clams $1\frac{3}{16}$ inches in length were planted. In six months they were removed, and the length of each individual carefully measured. There was some individual variation in the length; so the mean length of the series was calculated. It was found to be $1\frac{12}{16}$ inches. The average volume of clams $1\frac{3}{16}$ inches long is 4.5 c.cm; that of individuals $1\frac{12}{16}$ inches long is

14.5 c.cm, or 3.22 times as great. The increase in volume in the six months, therefore, was 222%.

Growth between tide lines

The most important point brought out in this experiment is the fact that growth is considerable on bottoms exposed for several hours at low tide. This is shown in the following cases.

A line of flowerpots was run from below ordinary low water mark up the steeply sloping beach to a point about two feet below the ordinary high water line, the fall of the tide being about six feet. The pots were sunk so that their tops were level with the ground, and were separated by a space of about two feet. June 19, 1901, there was placed in each of these pots a clam 1.25 inches, or — to give the measurements for convenience's sake in sixteenths of one inch — $1\frac{4}{16}$ inches in length. These were examined, after an interval of six months, on Dec. 28. Some of the pots were empty or contained dead shells. In the first or highest, the clam had grown to a length of $1\frac{11}{16}$ inches, an increase of 148% in volume in the half year. If we had no other example of growth, this would be very suggestive, for the increase is great, the creature having become in this short period almost two and a half times as large as when planted.

We should expect to find still greater growth with longer immersion. In the second pot, the clam had increased 154%, and in the third, still lower down, 172%.

The fourth pot was empty. In the fifth, the increase, instead of being greater still, was only 87%. The explanation of this seems to be perfectly clear, and is exemplified in several other cases. Around the margin of this pot there had grown a large quantity of Ulva. There was much of it at this level of the beach, while higher up it was not abundant. Without doubt this seaweed was flattened out over the top of the pot by the current, in such a way as to prevent free access to the food-bearing stream, and for this reason growth was not so rapid.

The presence of these weeds, which grow on so many bottoms, should not seriously inconvenience the clam culturist. They may be removed without difficulty with a rake, and do not grow abundantly on a surface which is reasonably smooth. If it had

been possible to visit these beds a few times during the summer, the results in the case of many lower beds would undoubtedly have been different.

In pots still lower down, all of which were covered with Ulva, the growth was much the same as in the fifth — from 80% to 100% increase.

In this line of pots, then, the fact is demonstrated that between tide lines, hard clams 1.25 inches long may increase 2.5 times or more in volume in half a year. Localities more favorable for their growth could easily be found. If experiments were made on a large scale, I should expect to get a more rapid average growth even where the forms were exposed at low tide, and a much greater increase on bottoms which are never exposed. As it is, this growth as compared with that of the oyster is marvelously rapid, just as it is in the soft clam.

It should be noticed that we are not attempting to make extended generalizations on the data given by four or five individual clams. Two clams side by side will not increase at the same rate. It is possible that one might grow twice as fast as another. But, if we had a single case in which we were certain of the amount of increase, it would assuredly indicate the possibilities of growth, and the chances are that it would not by any means be the limit of possibility.

On the other hand, when we compare the growth in pots 1, 2 and 3. and find a progressive increase from the higher to the lower pot — an increase of 145%, 154% and 172% — our induction is founded on insufficient data, and really means nothing. The result is as we should expect it, but it may be entirely accidental. But it is suggestive, and, if it were possible to observe many rows of clams similarly placed, we might reasonably expect to establish it. Unfortunately it has not been possible to do this.

The simple case of the line of flowerpots has been spoken of first because it was more or less typical of the results obtained in many small beds planted under similar conditions. Many hundreds of clams, after being carefully measured, were segregated into groups according to length and planted together. Their growth substantiates the results obtained in the flowerpots.

Very briefly the following results will be described. Several small beds, each with an area of 16 square feet, were laid out on the gravel between tide lines. A group of these was separated by an interval of 20 or 30 yards from another group. Most of these small plots were within the boundaries of the oyster bed already mentioned, but some were above the line of the bed, and a few of them were dug clean. Others were not discovered by clam diggers, and apparently entirely escaped molestation.

In each of these small beds, clams all of a size were planted. The number on a bed varied from 100 to 175. I would call particular attention to the fact that on the deeper beds, where the tide currents were swiftest, larger stones were exposed, and there was here an abundant growth of seaweed, which was not found farther up on the beach. This always interfered seriously with the growth of the clams.

For example, on these beds which were below the ordinary low tide line, where we should expect to find the most rapid growth, there was an increase in volume in clams $1\frac{12}{16}$ inches long, of 35%; in those $1\frac{4}{16}$ inches long, of 41%; and in those $1\frac{10}{16}$ inches long of 42%. I am all the more certain that this low rate of growth is to be explained by the presence of the seaweed, because I had previously had the same experience in a much larger experiment in the soft clam. Fortunately, as I have already stated, a little labor by one who is able to be on the spot during the entire year would prevent this result.

Some of the higher beds, however, which from the character of the bottom were free from the weed, gave different results, and show the possibilities of growth much better. On a bed only three or four feet from ordinary high water line, there was placed on July 6, 130 clams, $1\frac{4}{16}$ inches long. On Dec. 30, almost the entire number was removed. Some had increased more than others. The mean of the series was calculated, and showed an increase of 255% in volume in a little less than six months.

On another bed, somewhat lower, 150 clams $1\frac{6}{16}$ inches long had increased 157% in volume. One of the things to be expected is that clams of smaller size would show a relatively greater growth. It has not been possible to make comparisons to demonstrate this

because of the influence of the seaweed on so many beds. The variation in the size of planted clams in this experiment was from $1\frac{2}{16}$ inches to $1\frac{8}{16}$ inches in length, and this is not a very great range.

On a third bed, also situated well up on the beach, clams $1\frac{8}{16}$ inches long when planted had increased 155% in volume in the six months. Whether the amount of food in the summer is greater than in the winter, I do not know. I have no doubt that the increase goes on during the winter months, though, it may be, with diminished rapidity. It would be extremely interesting to carry out these experiments on a large scale through the entire year. These facts certainly show that the possibilities of growth in Venus are very great, and indicate that its artificial culture between tide lines would be easy and inexpensive, and that it would yield large results. Considering the place which the little-neck has in the markets, it would seem that the artificial culture of the form should yield a larger income than does the culture of the oyster as carried on in Long Island sound. The latter is expensive and laborious, and growth is very much slower than in the case of either of the clams.

Wandering habits of Venus

The soft or long-neck clam, Mya, is capable of locomotion only when very small. As the body increases in size, the foot, or locomotor organ, becomes relatively smaller. An individual 2 inches long, while it can not move along the surface of the bottom, is still able to use the foot as a burrowing organ. When it has attained a length of 3 or more inches, however, it seems to be incapable even of covering itself in the bottom.

In the case of the hard clam, Venus, on the contrary, the foot remains throughout life a very well developed locomotor organ. Though no definite experiments have been made to demonstrate what it is able to do, one might assume, from the size of the organ and its power of extension as demonstrated in aquaria, that the animal is able at all times in its life, not only to burrow but also to move from one locality to another, as the fresh-water clams, with a similar foot, are known to do.

The beds in this experiment were planted with the fear that the clams would wander. The result, however, showed conclusively that they do not have this habit — or that they did not exhibit it in this particular case. The clams were found where they were placed within the limits of the original beds. Careful digging around the margins of the beds failed in every instance to show any wandering tendencies.

Growth under wire netting

In order to be perfectly certain that clams should have no means of escape, three cages of wire netting were constructed, bounding the margins of the area containing clams in each case to a depth of 5 inches and covering the top. These forms never burrow to a greater depth than this, and there was no possibility of escape. In each case the netting remained intact, and certainly was not disturbed. These beds were exposed only during the full moon tides. Here also the seaweed seemed to play an important part in the results. In one case the netting was sunk so deep as to be covered with sand, and consequently no seaweed attached, as it did on the other cages. Growth was much more rapid here, though the clams in this bed were smaller when planted, and, as a consequence, a more rapid growth should have been expected. The results were as follows:

Cage 1 Clams planted July 6, $1\frac{8}{16}$ inches long. Some seaweed was attached to the wire of the cage. The clams were removed Dec. 30. The increase in volume was 145%.

Cage 2 Planted July 6, $1\frac{6}{16}$ inches in length. Removed Dec. 30. A very large quantity of weed over the cage. Increase in volume, 78%.

Cage 3 Planted July 6, 1^{4} inches long. This cage was sunk so deep that no weed was attached on the surface. The increase Dec. 30 was 222% in volume in the six months.

Growth above the bottom

In methods of oyster culture as developed in France, the forms are placed in racks above the bottom, and from the tide which sweeps over them, they are enabled to obtain nourishment enough for comparatively rapid growth. It would be an interesting

thing to show that clams could be made to grow in this way. The clam culturist could then make himself independent of beach rights, and perhaps more easily obtain a lease of ground for such a purpose below low water mark.

But one or two very small experiments on the soft clam have indicated that the creatures do not do well under these conditions. At Cold Spring a wire rack was constructed, and anchored above the bottom in a swift current. Into it were put several hard clams ranging from $1\frac{4}{16}$ to $2\frac{12}{16}$ inches in length. Every one of these seemed to be in a healthy condition at the end of six months, but not one had increased a particle in size. Not being able to cover the body in sand, they seem to have remained most of the time with valves closed. They may possibly have moved about at times, for their shells were worn, but more likely this was due to the fact that they were rolled about in the cage by the currents. On their smooth, clean surfaces numbers of Anomias, or silver shells, had attached and grown, as shown in figure 6.

Though this small attempt to induce growth above the bottom ended in failure, it should, on account of its importance, be repeated on a large scale under as many different conditions as possible, in the hope that some combination of circumstances might prove to be the right one.

Enemies

Neither of the clams is molested by the starfish after it has become large enough to burrow, though the very small soft clam, and perhaps the hard clam also, is destroyed in great numbers by small starfish, before it is able to cover itself. So far as I have been able to discover, there is but one natural enemy of Venus which might possibly be destructive. It is the gastropod mollusk, Lunatia [fig. 7], which is abundant in some localities. It is found in numbers at Cold Spring. On several occasions I have observed it digging below the surface and attacking both hard and soft clams in their burrows. By long continued labor, it files a smooth, clean hole through the shell of its victim by means of a rasping organ in its mouth cavity, and then destroys the soft parts of the body within. Figure 8 illustrates the character of the borings on shells

taken from the beds at Cold Spring. In every case the perforation is near the prominence of the shell called the umbo, directly over the pulpy visceral mass, which might most easily be sucked up through the opening. It is a curious fact that this region of the shell is selected by Lunatia for boring in any lamellibranch which it attacks. It may not invariably be so, but I have many shells of different species which have been drilled in this region, and have happened to notice no exceptions to it.

No matter how numerous it might be, this enemy would probably not be as troublesome to clam culture as the starfish is to the oyster industry. In several places I have seen it collected by fishermen for bait, simply by pegging a bit of fish, or even a dead starfish on the bottom. In a short time numbers of them will be found collected on the bait. By some such simple means, if it were desirable, a clam bed probably could easily be rid of the creatures.

Conclusion

This experiment on the growth of Venus from lack of means and time and favorable locality has been a limited one. In order fully to demonstrate the feasibility of the artificial culture of the form, it should be carried out on a very much larger scale, and should be extended through a longer period of time. There can be no doubt about the accuracy of the results in the case of the wire cages, the growth in which has been described; and, from their position, I have no reason to think that the clams were disturbed on the other beds which have been cited as examples of growth. Some of the higher beds seem to have been discovered by clammers, and these were raked clean.

The figures giving the percentages of growth, though not numerous, at least indicate the fact that the most essential feature of the culture of the little-neck clam — rapidity of growth — is all that could be desired. Neither has anything appeared which would suggest a natural difficulty in the way of artificial culture.

DESCRIPTION OF FIGURES

Figure 1

Side view of large *Venus mercenaria*. Mantle fold on right side of the body has been removed. The edge of the left fold of the mantle is shown at *m*. The exhalent, *ex. s*, and inhalent, *in. s*, siphons are modified parts of the mantle.

Water bearing food and other floating substances enters the space between the mantle folds — the mantle chamber — through the inhalent siphon. Hanging in this chamber are the foot, *f*, and gills, *og* and *ig*. Cilia on the gills cause water to enter them, forcing it to their bases, into the epibranchial chambers, *ec*, and then backward and out of the body through the excurrent siphon. This is indicated by fine, dotted arrows. The two large transverse muscles — the anterior and posterior adductors — which, by their contraction, close the valves of the shell, are shown at *aa* and *pa*.

Reference letters: *aa*, anterior adductor muscle; *pa*, posterior adductor muscle; *ec*, epibranchial chamber; *og* and *ig*, outer and inner gills; *ap* and *pp*, anterior and posterior palps; *ex. s* and *in. s*, exhalent and inhalent siphons; *f*, foot; *m*, edge of left mantle fold; *s*, ventral margin of shell.

Figure 2

Drawn to show that floating particles which touch the surface of the visceral mass are taken posteriorly and thrown off into the mantle chamber at x. From this region, they are removed from the body by the contraction of the adductor muscles, which discharges a large part of the water in the mantle chamber.

At *pp* is shown the striation of the inner side of the posterior palp, over which food is taken to the mouth. The unstriated margin is also shown.

Other reference letters as in figure 1.

Figure 3

Paper model of lamellibranch gill. A diagrammatic figure to show the basketlike structure of the gill.

Reference letters: *ic*, interfilamentar connections; *p*, partition or septum holding the two halves of the gill together; *r*, a rod or filament; *s*, space between filaments.

Figure 4

Diagrammatic section across the filaments of a typical gill. Arrows represent the course taken by water which enters the gill. Reference letters: *ig*, interior of gill; *p*, septum between sides; *gc*, gland cells, the secretion from which cements floating particles into a mass on the outer surfaces of the gill; *fc*, fine frontal cilia causing water to enter gill; *sc*, straining cilia preventing solid matter from entering the gill and moving it to the ventral margin.

Figure 5

View of inner surface of left mantle fold of Venus, showing course taken by particles which touch it. These are discharged from the body when the stream entering the mantle chamber through the lower siphon is reversed by contraction of adductor muscles.

Figure 6

Hard clams kept in wire cage above the bottom for six months. All shells were covered by attached Anomia, or silver shells.

Figure 7

Lunatia, a gastropod mollusk, which bores shells and destroys clams.

Figure 8

Venus shells bored by Lunatia.

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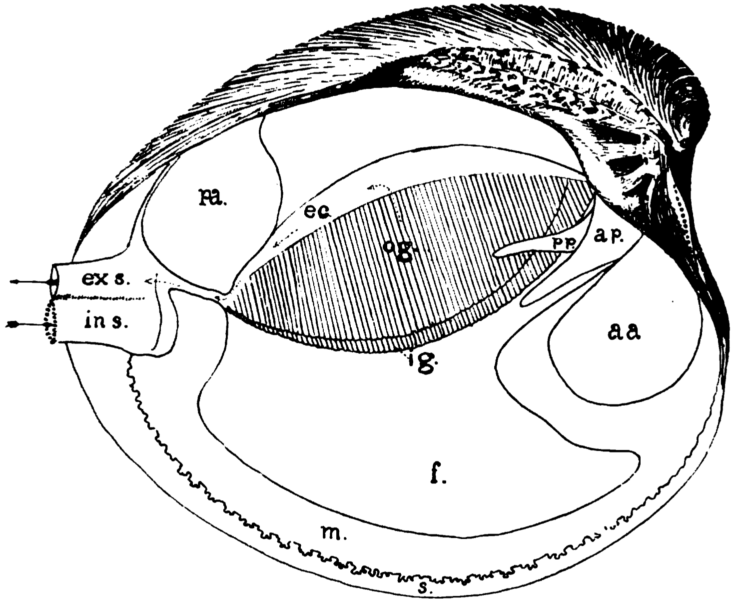

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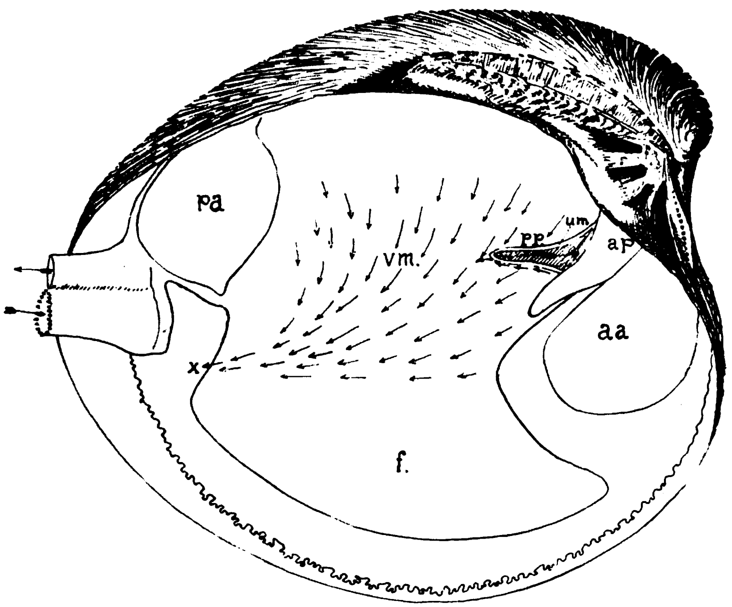

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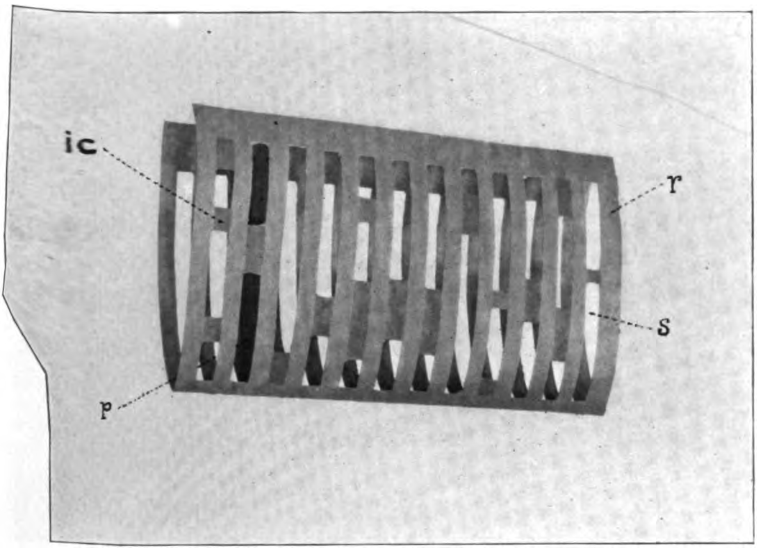

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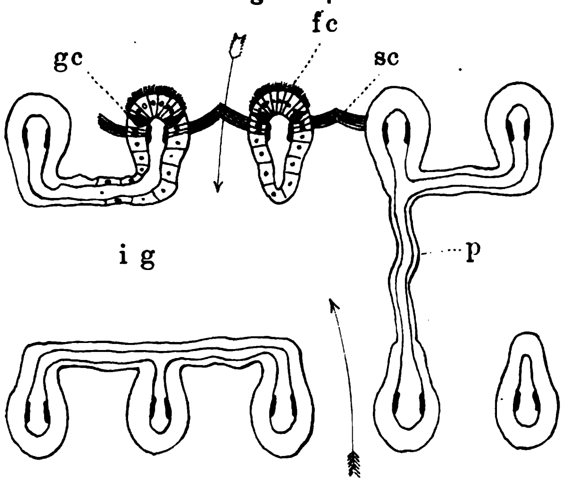

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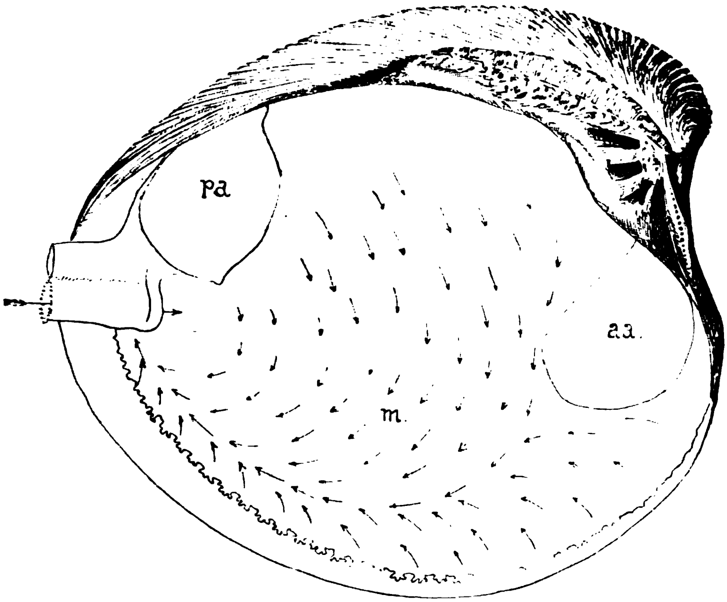

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Figure 7

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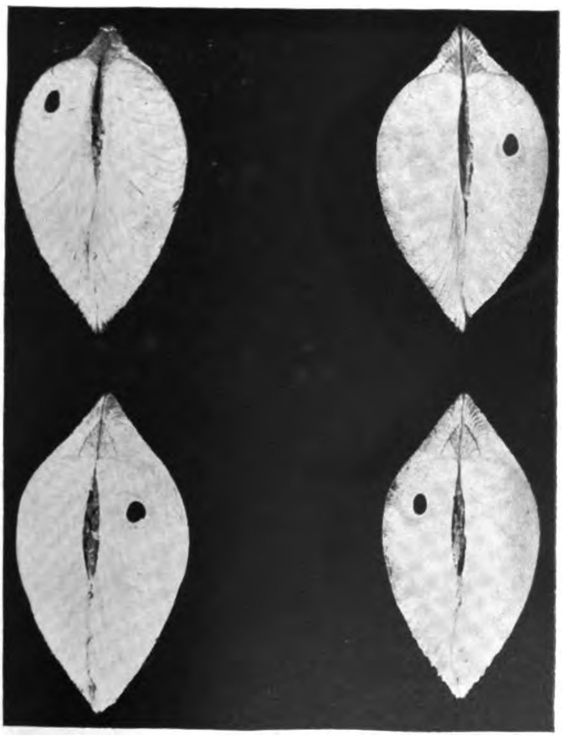

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Museum annual reports 1847–date. *All in print to 1892, 50c a volume, 75c in cloth; 1892–date, 75c, cloth.*

These reports are made up of the reports of the director, geologist, paleontologist, botanist and entomologist, and museum bulletins and memoirs, issued as advance sections of the reports.

Geologist's annual reports 1881–date. Rep'ts 1, 3–13, 17–date, O; 2, 14–16, Q.

The annual reports of the early natural history survey, 1837–41 are out of print.

Reports 1–4, 1881–84 were published only in separate form. Of the fifth report four pages were reprinted in the 39th museum report, and a supplement to the 6th report was included in the 40th museum report. The 7th and subsequent reports are included in the 41st and following museum reports, except that certain lithographic plates in the 11th report (1891) and 13th (1893) are omitted from the 45th and 47th museum reports.

Separate volumes of the following only are available.

Report	*Price*	*Report*	*Price*	*Report*	*Price*
12 (1892)	$.50	16	$1	19	$.40
14	.75	17	.75	20	.50
15, 2v.	2	18	.75	21	.40

In 1898 the paleontologic work of the State was made distinct from the geologic and will hereafter be reported separately.

Paleontologist's annual reports 1899–date.

See fourth note under Geologist's annual reports.

Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Since 1901 these reports have been issued as bulletins.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882–date.

Reports 3–17 bound also with museum reports 40-46, 48-55 of which they form a part. Since 1898 these reports have been issued as bulletins. Reports 3-4 are out of print, other reports with prices are:

Report	*Price*	*Report*	*Price*	*Report*	*Price*
1	$.50	8	$.25	13	$.10
2	.30	9	.25	14 (Ent. bul. 5)	.20
5	.25	10	.35	15 (" 9)	.15
6	.15	11	.25	16 (" 10)	.25
7	.20	12	.25	17 (" 14)	.30
				18 (" 17)	.20

Reports 2, 8-12 may also be obtained bound separately in cloth at 25c in addition to the price given above.

Botanist's annual reports 1867–date.

Bound also with museum reports 21-date of which they form a part; the first botanist's report appeared in the 21st museum report and is numbered 21. Reports 21-24, 29, 31-41 were not published separately.

Separate reports 25-28, 30, 42-50 and 52 (Botany bulletin 3), are out of print. Report 51 may be had for 40c: 53 for 20c; 54 for 50c; 55 (Botany bulletin 5) for 40c; 56 (Botany bulletin 6) for 50c. Since 1901 these reports have been issued as bulletins.

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have been published in volumes 1 and 3 of the 48th museum report and in volume 1 of the 49th, 51st, 52d, 54th and 55th reports. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and, combined with others more recently prepared, constitute Museum memoir 4.

Museum bulletins 1887–date. O. *To advance subscribers, $2 a year or 50c a year for those of any one division:* (1) *geology, economic geology, mineralogy, general zoology, archeology and miscellaneous,* (2) *paleontology,* (3) *botany,* (4) *entomology.*

Bulletins are also found with the annual reports of the museum as follows:

Bulletin	*Report*	*Bulletin*	*Report*	*Bulletin*	*Report*
12–15	48, v. 1	20–25	52, v. 1	35–36	54, v. 2
16–17	50 "	26–31	53 "	37–44	" v. 3
18–19	51 "	32–34	54 "	45–48	" v. 4
				49–54	55, v. 1

The figures in parentheses indicate the bulletin's number as a New York State Museum bulletin.

Geology. **G1 (14)** Kemp, J. F. Geology of Moriah and Westport Townships Essex Co. N. Y., with notes on the iron mines. 38p. 7pl. 2 maps, Sep. 1895. *10c.*

G2 (19) Merrill, F: J. H. Guide to the Study of the Geological Collections of the New York State Museum. 162p. 119pl. map. Nov. 1898. [*50c*] *New edition in preparation.*

G3 (21) Kemp, J. F. Geology of the Lake Placid Region. 24p. 1pl. map. Sep. 1898. *5c.*

G4 (48) Woodworth, J. B. Pleistocene Geology of Nassau County and Borough of Queens. 58p. il. 9pl. map. Dec. 1901. *25c.*

G5 (56) Merrill, F: J. H. Description of the State Geologic Map of 1901. 42p. 2 maps, tab. Oct. 1902. *10c.*

G6 Cushing, H. P. Geology of the Vicinity of Little Falls, Herkimer Co. *In preparation.*

—— Crystalline Rocks of the Northeastern Adirondacks. *In preparation.*

Kemp, J. F. Crystalline Rocks of Warren and Washington Counties. *In preparation.*

Woodworth, J. B. Glacial Geology of New York. *In preparation.*

Economic geology. Eg1 (3) Smock, J: C. Building Stone in the State of New York. 152p. Mar. 1888. *Out of print.*

Eg2 (7) —— First Report on the Iron Mines and Iron Ore Districts in New York. 6+70p. map. June 1889. *Out of print.*

Eg3 (10) —— Building Stone in New York. 210p. map, tab. Sep. 1890. *40c.*

Eg4 (11) Merrill, F: J. H. Salt and Gypsum Industries in New York. 92p. 12pl. 2 maps, 11 tab. Ap. 1893. *40c.*

Eg5 (12) Ries, Heinrich. Clay Industries of New York. 174p. 2pl. map. Mar. 1895. *30c.*

Eg6 (15) Merrill, F: J. H. Mineral Resources of New York. 224p. 2 maps. Sep. 1895. *50c.*

Eg7 (17) —— Road Materials and Road Building in New York. 52p. 14pl. 2 maps 34x45, 68x92 cm. Oct. 1897. *15c.*

Maps separate 10c each, 2 for 15c.

Eg8 (30) Orton, Edward. Petroleum and Natural Gas in New York. 136p. il. 3 maps. Nov. 1899. *15c.*

Eg9 (35) Ries, Heinrich. Clays of New York; their Properties and Uses. 456p. 140pl. map. June 1900. *$1, cloth.*

Eg10 (44) —— Lime and Cement Industries of New York; Eckel, E. C. Chapters on the Cement Industry. 332p. 101pl. 2 maps. Dec. 1901. *85c, cloth.*

Eg11 (61) Dickinson, H. T. Quarries of Bluestone and other Sandstones in New York. 108p. 18pl. 2 maps. Mar. 1903. *35c.*

Mineralogy. M1 (4) Nason, F. L. Some New York Minerals and their Localities. 20p. 1pl. Aug. 1888. [*10c*]

M2 (58) Whitlock, H. P. Guide to the Mineralogic Collections of the New York State Museum. 150p. il. 39pl. 11 models. Sep. 1902. *40c.*

M3 (70) —— New York Mineral Localities. *In press.*

Paleontology. Pa1 (34) Cumings, E. R. Lower Silurian System of Eastern Montgomery County; Prosser, C: S. Notes on the Stratigraphy of Mohawk Valley and Saratoga County, N. Y. 74p. 10pl. map. May 1900. *15c.*

Pa2 (39) Clarke, J: M.; Simpson, G: B. & Loomis, F: B. Paleontologic Papers 1. 72p. il. 16pl. Oct. 1900. *15c.*

Contents: Clarke, J: M. A Remarkable Occurrence of Orthoceras in the Oneonta Beds of the Chenango Valley, N. Y.
—Paropsonema cryptophya; a Peculiar Echinoderm from the Intumescens-zone (Portage Beds) of Western New York.
—Dictyonine Hexactinellid Sponges from the Upper Devonic of New York.
—The Water Biscuit of Squaw Island, Canandaigua Lake, N. Y.
Simpson, G: B. Preliminary Descriptions of New Genera of Paleozoic Rugose Corals.
Loomis, F: B. Siluric Fungi from Western New York.

Pa3 **(42)** Ruedemann, Rudolf. Hudson River Beds near Albany and their Taxonomic Equivalents. 114p. 2pl. map. Ap. 1901. *25c.*

Pa4 **(45)** Grabau, A. W. Geology and Paleontology of Niagara Falls and Vicinity. 286p. il. 18pl. map. Ap. 1901. *65c; cloth 90c.*

Pa5 **(49)** Ruedemann, Rudolf; Clarke, J: M. & Wood, Elvira. Paleontologic Papers 2. 240p. 13pl. Dec. 1901. *40c.*

Contents: Ruedemann, Rudolf. Trenton Conglomerate of Rysedorph Hill.
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Wood, Elvira. Marcellus Limestones of Lancaster, Erie Co. N. Y.
Clarke, J: M. New Agelacrinites.
——Value of Amnigenia as an Indicator of Fresh-water Deposits during the Devonic of New York, Ireland and the Rhineland.

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Museum memoirs 1889-date. Q.

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2 Hall, James & Clarke, J: M. Paleozoic Reticulate Sponges. 350p. il. 70pl. 1898. *$1, cloth.*

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New York State Museum

PUBLICATIONS (continued)

3 Clarke, J: M. The Oriskany Fauna of Becraft Mountain, Columbia Co. N. Y. 128p. 9pl. Oct. 1900. *80c.*

4 Peck, C: H. N. Y. Edible Fungi, 1895–99. 106p. 25pl. Nov. 1900. *75c.*
This includes revised descriptions and illustrations of fungi reported in the 49th, 51st and 52d reports of the state botanist.

5 Clarke, J: M. & Ruedemann, Rudolf. Guelph Formation and Fauna of New York State. 196p. 21pl. July 1903. *$1.50, cloth.*

6 —— Naples Fauna in Western New York. *In press.*

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H19 Classification of New York Series of Geologic Formations. 28p. *3c.*

Maps. Merrill, F: J. H. Economic and Geologic Map of the State of New York; issued as part of Museum bulletin 15 and the 48th Museum Report, v. 1. 59x67 cm. 1894. Scale 14 miles to 1 inch. *Separate edition out of print.*

—— Geologic Map of New York. 1901. Scale 5 miles to 1 inch. *In atlas form $3; mounted on rollers $5. Lower Hudson sheet 60c.*
The lower Hudson sheet, geologically colored, comprises Rockland, Orange, Dutchess, Putnam, Westchester, New York, Richmond, Kings, Queens and Nassau counties, and parts of Sullivan, Ulster and Suffolk counties; also northeastern New Jersey and part of western Connecticut.

—— Map of New York showing the Surface Configuration and Water Sheds. 1901. Scale 12 miles to 1 inch. *15c.*

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New York State Museum

FREDERICK J. H. MERRILL Director
EPHRAIM PORTER FELT State Entomologist

Bulletin 72

ENTOMOLOGY 19

GRAPEVINE ROOT WORM

BY

EPHRAIM PORTER FELT D.Sc.

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ALBANY

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University of the State of New York

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Bulletin 72

ENTOMOLOGY 19

GRAPEVINE ROOT WORM

PREFACE

The grapevine root worm has proved itself such a destructive enemy of vineyards in the Chautauqua grape belt, and so little success has attended efforts to control it, that it was deemed advisable in 1902 to undertake an investigation of this insect. The work of last year was embodied in Museum bulletin 59, and the material additions to our knowledge of this pest, gained in 1903, have rendered it advisable to issue an extended and revised edition of our previous publication, because the subject is of such vital importance that our growers should have all available information at their disposal. Many valuable facts have been ascertained during the last two seasons; and the additional data gained in 1903 demonstrate the value of timely cultivation and prove that collecting the beetles is practical, the most reliable and probably the most economical method of controlling this very serious enemy of the vine.

Through the courtesy of the Hon. C. A. Wieting, commissioner of agriculture, the entomologist has been able to avail himself of the services of nursery inspector J. Jay Barden who has cooperated with the writer very efficiently, and most of the field investigations were carried on with the assistance of this gentleman. Acknowledgment is due Mr D. K. Falvay of Westfield, who kindly placed a portion of his excellent vineyard at our disposal and cooperated with us most efficiently, thereby not only benefiting himself but aiding materially in demonstrating a practical

method of controlling this pest, after it had become well established in a vineyard. The breeding cage and other office experiments have been conducted under the writer's direction by his first assistant, Mr C. M. Walker, aided by the second assistant, Mr D. B. Young. The author is also under obligations to Prof. Percy J. Parrott, entomologist of the Ohio Agricultural Experiment Station, and Prof. A. F. Burgess, chief San José scale inspector of Ohio, who kindly accompanied him in his investigation of conditions in that state in 1902 and supplied additional information in 1903.

E. P. Felt

Albany N. Y. September 1903

GRAVEVINE ROOT WORM

Fidia viticida Walsh

Ord. *Coleoptera* Fam. *Chrysomelidae*

INTRODUCTION

The control of this pest in the Chautauqua grape belt is a serious problem which we have attempted to solve. The insect has, in recent years, caused enormous damages in the Ohio grape belt and now occurs in large numbers in Portland, Westfield and Ripley and has obtained a foothold over a large area. Messrs Walter Northrop and F. A. Morehouse estimated in the spring of 1902 that over 80 acres of magnificent vineyards had been destroyed or ruined by the pest in the vicinity of Ripley, and our investigations at the present time show that the area of severe injury and damage is constantly increasing, and is liable to much greater extension in the next few years. We consider this insect a much more serious enemy of the vineyard than the well known grapevine leaf hopper or white fly,[1] the work of which was so apparent and destructive in 1902 and the preceding two or three years. This leaf hopper undoubtedly causes much mischief, but, as its operations are confined to the leaves, the amount of damage is easily seen and, when necessary, steps may be taken to control it. The root worm on the other hand inflicts its most serious injuries under ground, where its operations can not be readily observed, and in a great many instances a vine or an entire vineyard is entirely ruined before the grower observes any trouble. This pest only requires two or three years to ruin a vineyard; and this, in connection with the secrecy of its work and the feeding of the grubs on the large roots, where a small amount of girdling is fatal, renders it a most dangerous enemy. Worst of all, this insect exhibits a decided preference for the more thrifty vineyards and is found most abundantly on or beneath the most vigorous vines. We believe that 15 or 20 grubs about a vine or as many beetles on its foliage are sufficient to warrant the adoption of vigorous measures for the suppression of the pest, though we are well aware that many more are fre-

[1]Typhlocyba comes var. vitis Harris

quently seen in a vineyard still alive. The marvelous prolificacy of the insect, as demonstrated by our studies, justifies the belief that even a relatively small number are sufficient to threaten the welfare of a vineyard.

The season of 1902 was unusually favorable to vine growth, and the same is true of the past summer, a condition for which the grower should be thankful, since it has enabled the vines to withstand insect attacks more successfully.

Area infested. Ripley appears to be the original center of this insect's most destructive work, though it has been found generally present in small numbers in many vineyards where little evidence of serious injury occurs. The pest very probably made its way into the Chautauqua grape belt from Ohio; and our investigations in 1903 show that it is present in greater or less numbers from the state line as far east as Sheridan, if not farther and from the lake shore to the top of the adjacent hills. We have also found it in small numbers in Hudson river valley vineyards at Highland and Milton.

Signs of the insect's presence. The more destructive work of this pest is somewhat difficult to detect, and is usually indicated by a weakness in vines and a marked decrease in the amount of new wood. The indications of the presence of the beetles are so characteristic that there should be little trouble in locating them. The peculiar chainlike eaten areas, represented in numbers on plate 6, are very characteristic of the insect and differ so much from the work of most other pests that no difficulty should be experienced in identifying it. The beetles show a decided preference for leafy vines, and the general appearance of some very badly eaten ones is shown on plate 5. The feeding of the beetle is usually the first visible indication of its presence and is not accompanied at the outset by signs of material injury. As the attack progresses and the work on the roots becomes more injurious, the development of the fruit is severely checked and the bunches may be less than half their normal size. The growth of wood is also much reduced, and vines which are very badly infested may die in midsummer. Cases were brought to the writer's attention where plants which had grown over 6 feet of wood the preceding summer, wilted in June and died. Infested vines as a general thing become less thrifty, develop less and

less wood yearly till finally there is not enough to tie up. A portion of a vineyard very seriously injured and where there is not wood enough to tie up is represented on plate 3. This condition rapidly becomes worse, and soon, usually in two or three years after the insect has been present in numbers, there is no wood, and the vines are simply a small mass of foliage resting on an old stump as represented on plate 4.

The depredations of this pest are much more serious and usually first apparent on light sandy or poor soils, and in particular on gravelly knolls, though we have found the beetles much more abundant in rich, low, though not wet hollows. The insects seem to thrive under such conditions, and a deficient growth should lead to immediate investigation. Vines on rich clay soils in our experience are less injured by this pest, due probably to their greater resistant powers; and this appears to be the case in Ohio. It should be remembered that vineyards on heavy clay lands are not exempt from attack and should be closely watched and, if necessary, active measures employed to keep the number of beetles below the danger point.

The roots also afford a clue to the identity of the depredator. The young grubs eat away the small feeding branches, while the larger individuals gnaw the bark, particularly from the underside of the larger roots. They frequently eat away long strips, as represented on plate 1, figure 5, though occasionally a single grub may work along a somewhat sinuous path.

A native species. This serious pest of the vineyards is not, like many of the forms so injurious to agriculturists, an imported insect. It has long been known to occur in this country and its work on wild grapevines was observed before its depredations attracted notice in our vineyards. This insect may develop into a general pest of the grape and perhaps in time come to be as well known as the very destructive Colorado potato beetle, which is familiar to almost every farmer. It is very probable that this grape enemy was able to exist only in relatively small numbers on wild vines and hence was rarely very injurious. It seems to have developed a great fondness for some of our cultivated varieties, and the growing of these in large areas has enabled it to increase to an almost unparalleled degree. This may perhaps be cited as one of the cases

where the devotion of extensive tracts to one crop has resulted after years in a species formerly harmless becoming very destructive.

It is interesting to note in this connection that the insect is by no means new to New York State. There are examples of the beetles in the private collection of the late J. A. Lintner, which were taken in Schenectady in 1880 and on Virginia creeper at Albany in 1882, and yet so far as known there is no record of the species proving destructive in this section. The writer also met with the insect at Albany in considerable numbers on Virginia creeper in 1901, and, though he has frequently visited vineyards in the vicinity, no signs of the insect were observed. It is very possible that the death of vines in early years here and there may have been caused by this beetle and attributed by growers to other agencies, as was the case before Professor Webster discovered the identity of the depredator in Ohio.

Allies. This species belongs to the large family of leaf-eating beetles, known as the Chrysomelidae, a group which comprises some of our most destructive insects. To it belongs the notorious elm leaf beetle,[1] a species which has destroyed thousands of magnificient shade trees in the Hudson river valley, and may in a few years become a most serious enemy to elms in other sections of the State. The two asparagus beetles,[2] are well known enemies to the grower of this succulent vegetable. The familiar yellow and black striped squash bug[3] is another ally of this destructive grape pest, which is sometimes aided in its deadly work by the steely or grapevine flea beetle,[4] a species which has caused great injury in some New York vineyards during recent years. A number of other related forms, nearly as injurious as those named, could be easily listed. These destructive allies are mentioned in this connection simply that the grape grower may have some idea of what related species can do; and, while this pest may not prove so generally injurious as any of these, it has already demonstrated its ability to cause much mischief. We see no reason at present for thinking that the history of this

[1] Galerucella luteola Müll.
[2] Crioceris asparagi Linn. and C. 12-punctata Linn.
[3] Diabrotica vittata Fabr.
[4] Haltica chalybea Illg.

insect in Ohio may not be duplicated in the Chautauqua grape belt, and perhaps in other sections of the State where this fruit is largely grown.

Present conditions in Ohio. The destructive work of this serious pest has been known in Ohio for some years. It was first brought to the attention of Professor Webster in 1893. The similarity of conditions existing between the Ohio grape belt and the Chautauqua region led the entomologist to believe that valuable data could be secured by personally investigating the present status of the insect in Ohio. This interesting section was visited about the middle of September 1902, and much valuable information secured through the kindly cooperation of Prof. P. J. Parrott, entomologist of the Ohio Agricultural Experiment Station, Prof. A. F. Burgess, chief San José scale inspector, and a number of prominent growers. The local knowledge of conditions possessed by the two gentlemen named enabled us to visit the sections of most importance with very little loss of time. Some very precise and significant statements were obtained in 1902 from Mr T. S. Clymonts of Cleveland O., who is not only a grower but also a dealer and one who undoubtedly has as good a general knowledge of local conditions as any one in that section. He stated that in the Ohio belt, extending east and west of Cleveland, from Painesville to Avon and reaching back 5 miles from the lake, there had been a reduction in shipments of fully two thirds during recent years. In 1894, 2000 carloads of grapes were shipped from that section. This was reduced in 1900 to 900 and in 1901 to 600. Mr Clymonts estimated the output for 1902 at not over 500 carloads.

He stated that this reduction is due to various causes, the principal ones being the ravages of the grape root worm, the destruction caused by rot, and the prevailing low prices. He attributed fully one third of the entire reduction to the beetles' work and instanced a number of cases where vineyards of considerable size had been killed by the operations of this pest. He mentioned one vineyard of 60 acres, another of 25 acres, and stated that innumerable small pieces had been destroyed by the work of this insect, and added that the yield of one 60 acre vineyard had been cut from 10–12 carloads to 35–40 tons by its

operations. Mr Clymonts's observations led him to think that as a rule the younger vineyards, specially those planted in the last 10 or 12 years, suffered most, and that the old ones escaped with comparatively little harm. The most destructive work observed by him had been on sandy soil, or on ridges in other pieces. He also stated that vines set in an infested vineyard to fill vacancies do not thrive and are usually killed by the insect. A recent communication, Aug. 27, 1903, states that nothing has developed the present year to make it advisable to modify any of the above statements.

Mr J. W. Maxwell of Euclid stated in 1902 that 50% of the vineyards were dead in that section, and that in his opinion a large proportion of them died as a result of the operations of this insect. His crop of grapes in a large vineyard was reduced fully one fourth, the most of which he attributed to this pest. He stated that the Wordens and Brightons were killed first, while the Concords and Catawbas were not so badly injured. He also adds, in a letter dated Aug. 29, 1903, that renewing a vineyard with Niagara vines seems to be quite a success, since 800 roots set two years ago in vacancies all lived and have done well. We hope this will continue to be the case, but in the writer's opinion these recently set vines have just reached a very attractive condition, so far as the beetle is concerned, and he is afraid that injury may result in a year or two.

Mr W. H. Slade of East Cleveland estimated in 1902 that one fourth of the vineyards in that section had been destroyed by this insect pest, and according to his observations the Wordens and Catawbas suffered more than the Concords. The most serious damage in his experience was met with on the lighter soil of knolls.

Mr W. W. Dille of Nottingham was of the opinion in 1902 that there has been a decrease in recent years of 40% in the area devoted to grapes. He attributed this shrinkage about equally to the rot, which had been very prevalent, to the operations of the grape root worm, and prevailing low prices. He stated that the insect injuries had been limited mostly to the bluff and to vineyards in the near vicinity of the lake shore, those back and just under the bluff escaping with comparatively little damage. He considers the Concord as one of the most resistant varieties.

A number of other growers were interviewed in 1902, and some disparity of opinion naturally prevailed. It will be seen, however, that there are a number of well informed men in that section who attribute very serious injuries to this insect; and, while the estimates of some may be excessive, there can be no doubt that the pest has caused very serious losses. The season of 1902 was unfavorable for observing the work of this pest because the repeated rains enabled the vines to sustain much greater injury than they would in times when there was less moisture. These conditions prevented the making of personal observations on the destructiveness of the insect, and most of our data relating to this had to be obtained from the evidence of others.

Considerable attention was also given to the various remedial measures employed by different growers, and some diversity of opinion existed. A number had sprayed their vines with arsenate of lead and also with bordeaux mixture. A few were of the opinion that spraying with arsenate of lead is a very efficient check on the increase of the insect, while others believed that it was of comparatively little value. Mr T. S. Clymonts stated that spraying with the bordeaux mixture alone affords some protection, as the beetles migrate to untreated vines. This subject will be discussed more at length under "Remedial measures." Most of the growers agree that thorough cultivation assists the vines greatly in resisting the depredations of the grubs. Those on whose premises carbon bisulfid was used were not favorably impressed with the substance. They state that in any event the cost of application is excessive considering the prevailing low prices for grapes. Considerable injury was caused in certain vineyards by carbon bisulfid, and it is very doubtful if this measure can be used to advantage.

Early history. This insect was first brought to notice in 1866 when specimens were sent from Kentucky to Mr B. D. Walsh, afterward state entomologist of Illinois. This gentleman stated at the time that he had taken the beetle in small numbers in both north and south Illinois, and later in the same year described the species. He also received the insect the following year from St Louis and Bluffton Mo., where the adults were said to be eating both foliage and fruit. Prof. C. V. Riley, in his first

report on the *Injurious and Beneficial Insects of Missouri,* characterizes this species as one of the worst foes to the grapevine in Missouri. This condemnation was based solely on the operations of the beetle on the leaves, an injury which is now regarded as of little importance compared with the work on the roots. Professor Riley received specimens from Bunker Hill Ill. in 1870, and in 1873 Mr G. R. Crotch described the insect[1] and gave its recorded distribution as the Middle and Southern states. The identity of the species described by Mr Crotch and this insect was pointed out by Dr Horn in 1892, when he recorded its distribution as the "Middle states to Dakota, Florida and Texas." He also states that the insect described by Lefevre[2] belongs to this species. This pest was received from the vicinity of Iowa City Ia. by Prof. H. F. Wickham in 1888, and Professor Riley has recorded this form and an allied one[3] as injuring grape leaves at Vineland Ark.

Nothing further was known regarding this species till 1893, when specimens were sent to Prof. F. M. Webster, then of the Ohio Agricultural Experiment Station, who made an exhaustive study of the insect and published a detailed account of his investigations in 1895.

Injuries by this insect in the state of Arkansas were recorded by Prof. J. T. Stinson in 1896, and in the same year Professor Webster notes a decrease in the numbers of the pest in Ohio vineyards and attributes it as possibly due to the efficient work of two egg parasites and a small mite.[4] The following year Messrs Webster and Mally reported, as a result of a series of experiments, that tobacco dust and kainit were practically ineffective against this insect, and two years later these gentlemen record the unusual abundance of the pest in Ohio vineyards, and state that serious injuries occurred at Bloomington Ill. The presence of this beetle in destructive numbers in the Chautauqua grape belt was recorded by Prof. M. V. Slingerland in 1900, who at that time published a general compiled account of the insect. Dr J. B. Smith, in his *Catalog of the Insects of New*

[1] Fidia murina Crotch
[2] Fidia lurida Lefevre
[3] Fidia longipes Melsh
[4] Heteropus ventricosus Newport

Jersey states that this species occurs throughout New Jersey on the grape and Virginia creeper or Ampelopsis, and he also records it from Staten Island. A brief note published by Dr L. O. Howard in 1901 states that the depredations of this insect at Bloomington Ill. continue unabated and severe damage to vineyards is recorded. The writer, in the early spring of 1902, published a brief notice of the extent of the injuries in the Chautauqua grape belt with a summary of the life history of the pest and outlined a series of experiments for that year, which are reported on in detail in this bulletin together with the results obtained in 1903.

DESCRIPTION

The perfect insect is a small, brown, rather robust beetle about $\frac{1}{4}$ inch in length and rather densely covered with short grayish white hairs. It may be recognized by aid of plate 1, figure 1.

The egg is about $\frac{1}{25}$ inch in length with a transverse diameter about one fourth as great. Form, nearly cylindric, tapering a trifle at each end. The shell is flexible, and, when a number of eggs are crowded in a small space, they may become somewhat distorted. The eggs are white when first deposited, but soon assume a yellowish cast. On the fourth day a narrow semitransparent band appears near each end. The eggs of the clusters normally have a somewhat concentric arrangement, and range in number from 1 to 125. Several clusters are represented on plate 1, figure 3.

The young larva is creamy white, about $\frac{1}{17}$ inch in length and tapers somewhat posteriorly. The head is a pale, yellowish color with the mouth parts ranging from light to dark brown, the sutures and tips of the mandibles having the most color. The head is somewhat flattened, bilobed and with the posterior angles rounded. The mandibles are distinctly toothed. The body is slightly smaller than the head, convoluted and distinctly segmented. Each segment bears a transverse row of small tubercles, from each of which a long hair arises. The spiracles, or breathing pores, are darker than the body and usually light yellow.

The nearly full grown grub resembles the newly hatched individuals very much in general form and color. It is then

about ⅝ inch in length, with a yellowish brown head and the mouth parts and adjacent sutures dark brown or nearly black. The body has a greater transverse diameter than the head, is distinctly segmented and bears numerous irregular transverse rows of small setae, which are relatively much shorter than in recently hatched individuals. The spiracles are well marked and range in color from yellowish brown to light brown. The general appearance of the grub is shown on plate 1, figure 4. Its white color and curled form suggest the common white grub, in spite of its much smaller size.

The pupa ranges in length from about ¼ to ⅓ inch and its general features are represented on plate 1, figure 6. It may be recognized by its white color with a pinkish tint about the head, thorax and posterior extremity. The head is adorned with a semicircular row of four spines, the middle two being larger and nearly erect, the others smaller and more divergent. There is a similar row near the anterior margin of the thorax, though the curve is not so pronounced as on the head. Just behind this latter row there is a cluster of four smaller, nearly erect spines placed in pairs, the posterior being more widely separated. The anterior femora is armed at its tip with a stout hook, while above and at one side is a single straight, hair-tipped spine with sometimes a second one below. The posterior femora is likewise armed with a stout hook and with two hair-tipped spines. At the posterior extremity, there are two flattened, stout spines projecting dorsally. The penultimate segment is armed with a pair of small, median spines with a smaller pair of closely placed ones on each side, and on the antepenultimate there is a median cluster of four closely placed, hair-tipped spines, the inner two being smaller. There is also a lateral spine on each side [fig. 1]. The other segments are each provided with a single transverse row of minute, short bristles, and on the scutellum there is a median pair of larger ones.

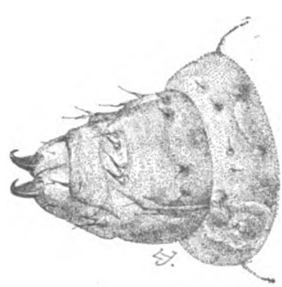

Fig. 1 Posterior segments of pupa (original)

This pupa may be known by its general form and coloration, and by the peculiar arrangement of the spines at its posterior extremity, as shown in the figure.

LIFE HISTORY

The life history of this insect may be summarized as follows: The winter is passed by the nearly full grown grubs in oval cells in the soil, and so far as our observations go the great majority of them occur from 10 to 12 inches below the surface and mostly near or in the subsoil. On the approach of warm weather, the grubs work upward, probably early in May in most years, and are then mostly within a few inches of the surface and usually within 15 to 24 inches of the stem of the grapevine, though some, and occasionally large numbers, may be found near the middle of the row. Usually very little feeding is done in the spring. The transformation to the pupa occurs in normal seasons from about June 1 to 20, the adults issuing approximately two weeks later or from about June 20 onward. The great majority of the beetles appear the last of June or early in July, though some do not emerge till the last of the month and in rare instances much later. A pupa was met with Aug. 15, 1902, and the adults have been found in New York vineyards as late as September and even in October. The latter are probably from belated larvae. The eggs are mostly laid in July and August under the loose bark of last year's wood and require a period of about two weeks to hatch. The young grubs make no attempt to crawl down but drop, and working under the loose soil make their way to the small feeding roots, where under favorable conditions they grow rapidly and after increasing considerably in size attack the larger roots, eating away long strips of the bark [pl. 1, fig. 5]. The latter, when a large number of grubs are present, may rest simply on a bed of borings. Many of the grubs attain nearly full size the latter part of August or early in September. Late in the fall the larvae descend to considerable depths, as previously noted, construct their oval cells and pass the winter within them.

Habits of the beetle. The habits of the beetle are of special interest because it is practicable to collect these insects and thus in a large measure prevent egg-laying and consequent damage from the grubs. Professor Webster states that the beetles normally begin to appear in northern Ohio about June 20. This agrees closely with our observations. The season of 1902 was remarkably late, and very few beetles were observed previous to

July 2, while in 1903 a few were taken June 19. Their first appearance was on light soil, and the insects did not begin to emerge in numbers on heavy land till nearly a week later. Our cage experiments [*see* table on p. 27] show that over 92% of the beetles appeared within two weeks after the first were taken, and practically none after July 21. In other words, out of 506 bred from under two vines, 477 emerged by July 21. The issuing of the insects is undoubtedly considerably modified by temperature, as demonstrated by the beetles appearing in unusually large numbers on the 26th, which was a bright, warm day. The time of appearance and the fact that a large proportion of the insects issue from the ground within two weeks are of much importance, if anything is to be done by collecting the insects. The beetles appear to emerge and remain on the foliage, particularly around buds, several days before they feed to any extent. Breeding cage experiments have fixed this period at from one to four days. Two beetles which actually emerged under observation refused food till the fourth day, and it is very probable that this period is nearly the normal time between the emergence of the beetles and feeding. A considerable number may be found before any feeding has taken place, as is evidenced by Mr Barden taking 12 from a vine which bore practically no marks of their eating. The insects may be found in a field over an extended period, which is not surprising in view of the fact that a beetle may live over nine weeks, as demonstrated by us this year. Some were observed by Mr T. T. Neill Sep. 4, 1902, in a vineyard at Fredonia, and Mr F. A. Morehouse states that he met with individuals in October 1902.

Oviposition does not occur till some days after the appearance of the perfect insects, and according to breeding cage observations this period may range from 10 to 17 days. Our breeding cage experiments also indicate that the insect may feed from 6 to 13 days before eggs are deposited. This period was carefully ascertained by isolating a series of males and females and providing them with as nearly natural conditions as possible. Both of these periods are much longer than normal, since eggs were found by Mr Barden in the Northrop vineyard July 9, 1902, where beetles were present in very small numbers on the 2d. This allows a maximum of only seven days between the appear-

ance of the earliest insects and the laying of eggs; and, if, as can hardly be questioned, the insects remain without taking food for two or three days, then the time of feeding before the deposition of eggs can hardly exceed an equal period. The first beetles were observed in 1903 on June 19, and a few contained nearly developed eggs July 2, at which time it was very warm and there were many pairing, and eggs were deposited a day or two later, making about two weeks between the appearance of the first beetles and the deposition of eggs. This period is a little longer than was the case in 1902, but even then does not equal our breeding cage records. This matter is of considerable importance because it shows how quickly collecting must be done or poisons must act in order to prevent the deposition of many eggs.

The feeding of the beetles occurs almost entirely on the upper surface of the leaves and, as described by Professor Webster, "is done by gathering a quantity of the substance of the leaf in the mandibles and jerking the head upwards, after which the body is moved a step forward and another mouthful of food secured as before. After securing a few mouthfuls in this way, they move to another place and begin again, thus eating out numerous chainlike rows of silk net" as shown on plates 5 and 6. "The insects usually eat only to the lower epidermis on foliage having a velvety undersurface, but on others they eat entirely through the leaf." The beetles are shy and retiring by nature and feed largely in sheltered places or among the growing tips, both difficult places to hit with a spray. A favorite retreat of the insects is among the tendrils clinging to the top wire. Many of those feeding on the leaves are easily frightened, and when alarmed usually fold up their legs and fall to the ground, where they remain quiet till all danger appears to have passed. They can spring readily either with the legs or when inverted by suddenly opening the wing covers and projecting themselves from the hand or other support. The beetles on the canes, however, are not so easily disturbed. They can frequently be picked from the vine, and it requires repeated jarring to dislodge all. This is of considerable importance when collecting beetles with any machine, and the persistence with which some hang to the wood is an objection to this method of

controlling the insect. They are, however, much more easily jarred from the vines on warm days.

The tendency of this species to remain in a locality for a time, at least, is well shown in a certain vineyard at Ripley. It had suffered very severely in earlier years from the depredations of this pest and a portion of it was uprooted in the spring of 1902. A small area was allowed to remain in the hope that it could be brought back to a normal condition. A few rows next to the uprooted area were fed on to a very great extent by the beetles, which had evidently emerged from the adjacent soil and made their way to the nearest vines, where they were content to remain and feed. The extensive injury inflicted on these vines is well illustrated on plate 5, which shows how badly many of the leaves were riddled. A curious fact in connection with the abundance of the beetles on these small vines is that few or no eggs could be found, probably due to the small amount of wood. Observations have shown that while there is undoubtedly a connection between the amount of feeding and the number of eggs laid, such is not necessarily true of the feeding and the number of eggs or grubs on particular vines. This is a matter of some importance because many growers are inclined to estimate the number of grubs at the roots by the amount of feeding on the foliage, whereas it frequently occurs that more grubs are found under vines with foliage but little eaten than under those which bear evidence of excessive feeding. This tendency of the insects to remain in a locality for a time is favorable to local control, since it gives an opportunity to destroy them by collecting before there is much dispersion. Such opportunities should be embraced promptly, because it is well known that at times the beetles fly to a considerable extent. Mr Schonfeldt has called the writer's attention to an instance where numbers of the insects suddenly appeared on some vines close to his house. They were so numerous that the rattling as they struck the foliage attracted the notice of Mrs Schonfeldt, who called her husband's attention to the sound. The day was warm, and consequently the beetles flew rapidly. As a rule, we believe, dispersion occurs more by a wandering individual flight than by movements in swarms. There is a marked tendency among the beetles to desert unthrifty vines, probably because of the poor shelter they offer, and to attack the

more vigorous, thrifty vineyards. It may be that a slight overcrowding, as in the case of some other insects, impels the beetles to flight. This means that poor vines are relatively safe, while the better ones are liable to injury and are consequently the places where it is most important to control the insect. These inflying beetles will lay eggs if conditions are favorable, and the earlier they appear the more eggs will be deposited.

Eggs. The eggs of this insect are deposited almost entirely under the loose bark of last year's wood, many being found as high as the top wire. Professor Webster states that over 700 have been taken from a single vine, and from a section 16 inches in length and an inch in diameter he took 225 eggs. Once he found a few eggs pushed down between the earth and the base of the vine, but we have failed to find eggs in any such position. Beetles in confinement deposited eggs in crevices and cavities of the wood and even on leaves. Eggs were found in the field in 1902 as early as July 9, and oviposition was still in progress Aug. 15, and, though beetles were less abundant than three weeks before, it was still easy to find individuals which contained fully developed eggs. The first deposited in 1903 were found about July 3, and in our indoor breeding cages oviposition continued till into September. Experiments were planned, both this year and last, to determine the duration of the period of oviposition, the time when the eggs were laid and the total number deposited by females. A number of pairs of beetles were isolated and provided daily with fresh food. The work in 1902 demonstrated that a number of beetles might continue to deposit eggs for a period of over 40 days, and certain individuals from seven to 13 days. These records gave totals of 187, 141 and 106 eggs for individuals. This was interesting, but it was felt that the limit had not been reached, and consequently the studies were conducted on a more extended scale this year, and the results more than justified the labor, as will be seen by the appended table.

Oviposition experiments with Fidia 1903

Beetles taken at Westfield July 2

		Pair 1	Pair 5	Pair 19	Stock jar 1	Stock jar 3	Check plant
July	4	30	....	....	(40♀)	(17♀)	(4♀)
	5	20	....	....	77	....	....
	6	21	....	....	25	....	....
	7	26	....	....	225	....	....
	8	20	....	....	30	75	....
	9	25	....	35	450	150	145
	10	35	....	....	300	175	40
	11	25	....	....	400	150	....
	12	30	....	10	650	100	....
	13	25	....	10	200	250	50
	14	....	....	....	150	40	25
	15	31	....	....	175	45	....
	16	....	140	....	30	....	150
	17	....	....	....	100	....	....
	18	33	25	....	175	125	25
	19	....	....	....	120	....	25
	20	....	....	....	20	....	50
	21	24	....	....	62	175	70
	22	....	....	75	25	10	40
	23	41	....	....	30	35	....
	24	30	....	26	200	50	75
	25	....	....	....	264	50	85
	26	24	....	....	185	300	160
	27	30	....	....	70	25	25
	28	....	....	....	62	....	....
	29	20	....	....	50	....	50
	30	....	....	....	130	50	50
	31	10	25	....	185	115	128
August	1	42	60	....	25	105	54
	2	....	....	....	....	50	70
	3	....	20	....	150	....	75
	4	11	....	All dead.	....	76	....
	5	....	....	....	75	....	130
	8	....	....	....	75	....	....
	10	56	....	....	58	18	....
	12	a16	72	....	73	....	95
	13	2	....	....	123	....	83
	14	36	....	....	25	....	....
	15	....	....	....	36	....	....
	17	42	....	....	90	23	36
	19	....	....	....	60	....	....
	20	45	....	....	75	....	....
	21	....	....	....	35	....	35
	22	36	....	....	70	....	166
	24	25	All dead.	....	40	15	28
	26	....	....	....	39	....	....
September	2	56	....	....	....	....	....
	4	14	....	....	....	....	....
	6	31	....	....	....	....	....
	11	♀ dead...	....	....	....	....	....
Totals.....		902	342	156	5 664	2 199	1 955
Average per female........		....	....	....	141	192	488

a 4.30 p. m.

An examination of the above record shows that one female taken July 2 began laying eggs July 4 and from then to the 13th deposited from 20 to 30 daily, and from the latter day onward the eggs were laid usually at intervals of one to several days, the periods of deposition being interspersed by intervals of feeding. There seems to be a very direct connection between the amount eaten and the number of eggs laid, which would be expected when it is remembered that a single female lived upward of two months and during that time deposited the enormous number of 902 eggs. This record is a striking testimony to the care bestowed on the insects by Mr Walker, who had charge of the breeding cage work. Analysis shows that 257, or over one fourth of the total number, were laid during the first 10 days, and 416, or nearly one half of the total number, in the first three weeks. This record is undoubtedly exceptional and probably approaches the maximum capacity of the insect, particularly in the field. It will be seen, however, that one other female deposited 342 and another 156 eggs, while averages of beetles kept in certain stock jars ranged from 141 to 192 and 488 to each female, and an average based on the entire record gives nearly 175 for each female. This indicates that our highest record, 902, may not be so very exceptional. A study of the entire number of eggs is not without interest, as it shows when the greatest number are deposited and consequently the time when the beetles should be destroyed in order to obtain the maximum benefit. A summarized table is given below.

Summary of oviposition record 1903

DATE	Pair 1	Pair 5	Pair 19	Stock jar 1	Stock jar 3	Check plant	Total	Per cent of total
July 4–18	321	165	55	2 987	1 110	435	5 073	45
July 19–31	179	25	......	1 403	810	758	3 175	†28
July 4–31	500	190	55	4 390	1 920	1 193	8 248	†73
Totals, July–Sep.........	902	342	156	5 664	2 199	1 955	11 173	....
Average per female........	902	342	156	141	192	488	....	....

It will be seen from an examination of this that 5073 eggs were deposited by all of the different beetles in the various jars between July 4 and 18 (or the first two weeks) making a total of

45% of the entire number, and that only 3175 were deposited between July 19 and 31 (or the following 12 days). It will also be observed that 8248 eggs were deposited by all the beetles during the month of July, and this amounts to over 73% of the entire number produced by the beetles under observation. In other words, a very large per cent of the eggs are deposited under normal conditions during the first two weeks after the beetles begin to lay, or during the first three or three and one half weeks of their existence. There is then a decided drop during the next 10 or 12 days, and a much greater falling off in the following weeks. This record probably represents very closely indeed what actually occurs in the field and emphasizes the necessity of destroying the insects early in their career, though it will be observed that considerable protection results even if the pests are not killed till three or four weeks after they appear above ground.

The beetles which made the records both this year and last were confined in jelly tumblers or fruit jars and were daily supplied with small pieces of cane and fresh leaves. Careful records were kept of all insects taken from the individual tumblers as well as the large breeding jars, and, while the conditions were by no means normal, it is manifest that valuable results were obtained. In nature, it is probable that natural causes would result in the death of many individuals early in their career, and the same is true in the breeding jars, though deaths in the latter are usually the result of confinement and unnatural conditions. One to a certain extent offsets the other, and the above records may be considered as giving a fair idea of what actually occurs in the field.

Our observations on eggs laid in breeding jars showed that they are deposited in masses of from 1 to 125, the latter being the largest number observed in one cluster. A normal egg mass measures about $\frac{1}{8}$ inch in length and less than one half that in breadth. The somewhat concentric arrangement of the eggs is shown on plate 1, figure 3. The rows of eggs often overlap each other like shingles, and in the center of the mass there is frequently an appearance of two or three layers. The egg clusters are sometimes deposited so that two thirds of the branch is encircled, and in each case the whole mass is covered with a sticky substance, which glues each egg to the other in

such a manner that the whole may be easily detached from the vine, as is often the case when a strong wind is blowing.

The duration of the egg stage was determined by repeated observations both last year and this as from 9 to 12 days, about one day being required for an entire mass of eggs to develop after hatching commenced. We were also able to verify Professor Webster's observation on the appearance of a narrow semitransparent band or line near each end of the egg four days after oviposition. Small numbers of empty egg shells, indicating that hatching had begun, were found in Mr G. L. Hough's vineyard July 24, 1902; and it is very probable that in Mr Clyde Dean's vineyard at Portland, where conditions are about a week earlier, young grubs had appeared some time before.

Habits of the grubs or larvae. The young larvae, after they hatch from the eggs, drop to the ground, as observed by Professor Webster and corroborated in our own experience. There seems to be very little or no attempt on the part of these tiny creatures to crawl down the stalk. A recently hatched grub is such a small creature that it rapidly makes its way into any crevice or crack, and when it drops on loose earth soon disappears from sight. Earlier writers have recommended the covering of the roots of grapevines as deeply as practicable at the time the young hatch, so as to present more obstacles to the grubs when making their way to the roots. This suggested to the writer some experiments to determine the burrowing and traveling powers of these little creatures. One small grub was placed on a piece of paper at 9.27 in the morning and its wanderings carefully traced with a pencil till 4.43 in the afternoon. The little creature traveled almost continuously during that entire period and showed a decided tendency to turn to the left. It covered the relatively enormous distance of over 47 feet in seven hours, or an average of about 2 yards an hour. The grub was placed in a dry vial, and under such unfavorable conditions lived about three days. This would seem to indicate that the little creatures can make their way over many obstacles if not confronted by very unfavorable conditions.

Some tests were also planned to ascertain the burrowing powers of these little grubs. A glass tube 17 inches long and ½ inch in diameter was bent so that 4 inches were vertical. It was then filled with loosely packed earth, and on July 29, 40

recently hatched grubs were placed on the surface of the soil in the 4 inch vertical portion. One grub had made its way through the entire mass of soil by July 31, another by Aug. 1, and 11 others by the 3d, making a total of 13 which had traveled the whole length of this tube in a period of four days.

Another ½ inch tube, 10 inches long with 3½ inches vertical and 6½ inches of its length horizontal was similarly packed and 13 grubs placed on the surface of the soil July 29. Four of these had made their way throughout the entire length of the tube by Aug. 3. Another tube 12 inches long, ½ inch in diameter, with 2½ inches of its length vertical and the remainder horizontal was filled with tightly packed soil and a number of grubs placed in it Aug. 1. On the 7th one grub had made its way through 7½ inches of this tightly packed material. It would seem from the above experiments that, while a great many grubs undoubtedly perish in making their way from the vine to the succulent roots on which they feed, they are capable of overcoming great obstacles, and the facts ascertained above at least raise a question as to the advisability of attempting to interpose barriers between the grub and the roots on which it feeds.

The young larvae or grubs are undoubtedly able to exist for some time without food. They soon make their way when possible to the young feeding roots, where they may sometimes be found in considerable numbers. The writer, in the middle of August 1902, succeeded in finding eight of these little creatures under a small bunch of feeding roots. They were less than one quarter grown, and under larger roots near them several others were found which were about half grown. Aug. 18, 1903, quarter and nearly full grown grubs were found in some Westfield vineyards. The occurrence of few half grown larvae and of considerable numbers of nearly full grown individuals the middle of September 1902 indicates that these creatures develop very rapidly after they have found suitable roots on which to feed. The finding of a small grub scarcely $\frac{1}{16}$ inch long July 2 shows that some do not attain their full growth in the fall, since this individual could not have hatched from an egg laid in 1902, as the beetles had hardly begun to appear, and that such individuals must feed to some extent in the spring. It seems probable that these very small grubs produce the later emerging beetles and are

therefore responsible to a limited degree for the very extended period during which adults are found abroad. Most of the grubs complete or nearly complete their growth in the early fall, and on the approach of cold weather descend deeper in the earth. Professor Webster records finding the grubs a foot below the surface in the spring, and our own observations indicate that they descend nearly to that depth, where they pass the winter in small oval cells. Their ascent in the spring occurs after the appearance of warm weather and probably some time in early May. Experiments in 1903 with grubs collected the latter part of April demonstrated the ability of full grown and apparently half grown larvae to complete their transformations with no more nourishment than is found in ordinary garden soil in which there are no grape roots. Those about quarter grown were not able to survive the test. On the other hand, some nearly full grown individuals were observed last spring feeding on the roots to a slight extent in our breeding cage.

Pupa. Professor Webster records the finding of a very few pupae as early as the first week in June, and Mr Barden states that in 1902 he observed the first pupae at Ripley June 7, though Mr Hough is of the opinion that the larvae began to transform as early as June 4. The great majority of the insects had transformed to this stage by June 23. The present season was considerably more advanced than that of last year, and 90% of the insects were in the pupal stage May 29, 1903, on light sandy loam. The cells are almost entirely within 2 or 3 inches of the surface and usually within 2 or 3 feet of the base of the vine.

The duration of the pupa stage has been stated by earlier writers as about a fortnight and actual observations with breeding cage material have enabled us to determine this period as from 13 to 14 days. These observations were made in the office, where temperature conditions were uniform and rather high, and it would not be surprising if this period was materially extended out of doors in unusually cool weather.

The oval cells occupied by the larvae can be broken repeatedly, and the grubs will make others, but such is not true of the pupae. The insects are so delicate in the latter stage that the writer has experienced great difficulty in transmitting them through the mails, even with most careful packing. This is shown by the fact that out of 58 mailed to Albany only 15 arrived alive; a number

were carefully packed in their cells or laid on moist cotton, otherwise the fatalities would have been much higher. Cage experiments in the field show that from 50% to 75% or even a larger proportion may be destroyed by timely cultivation [*see* p. 27]. These facts have a very important bearing on remedial measures, as will be pointed out under that head.

EXPERIMENTAL WORK IN 1903

This is a very convenient heading under which to group a number of records of work carried on under similar conditions, yielding data which can be readily tabulated and which should be discussed under various headings. This work was conducted in the vineyard of Mr D. K. Falvay of Westfield, who contributed not a little to its success.

Eight large, thrifty Concord vines of as nearly uniform size and conditions as could be determined by examination were carefully covered by wire cages [pl. 7, 8] so arranged that no insects such as Fidia could escape, nor could any enter from outside. The cages were numbered respectively from one to five, running from east to west. Numbers 1, 2 and 5 contained two vines each and numbers 3 and 4 but a single vine. Number 1 was a check cage, which was watched carefully for the purpose of comparing with conditions obtaining in other cages. Number 2 included two Concord vines around which the soil had been carefully hoed at the time the majority of the insects were in the pupal stage. The work was not more thorough than could have been done by a horse and cultivator. The vine in number 3 was sprayed with arsenate of lead, 1 pound to 50 gallons of water. The first application was made June 19 and the second June 27. The work was done by Mr Barden, who used a small hand atomizer and took special pains in each instance to cover every portion of the foliage so far as was possible. The vine in number 4 was sprayed with a poisoned bordeaux mixture, 6 pounds of copper sulfate, 6 pounds of lime and ¼ pound of paris green being used to 40 gallons of water. The spraying was done by the same person and in the same manner as in the case of cage 3. The vines in number 5 were reserved for the purpose of determining exactly when the beetles appear above ground, and it was visited at intervals of a few days to a week or thereabout and the beetles removed till practically all had emerged. The tabulated record is as follows:

Record of cage experiments 1903

Date		1 Check	2 Cultivation	3 Arsenate lead 4 lb to 50 gal.	4 Poisoned bordeaux mixture	5 Beetles collected
June	5		Carefully hoed to depth of 3 in.			
	19			Sprayed thoroughly	Sprayed thoroughly	
	22	8 beetles	2 beetles	24 beetles	18 beetles	22 beetles
	24	19 beetles	7 beetles, practically no feeding	36 beetles, some feeding	32 beetles, some feeding	75 beetles
	25					50 beetles, 6 p. m.
	26	41 beetles	10 beetles, much recent feeding	56 beetles, more feeding	56 beetles, more feeding	50 beetles, 11 a. m.
	27			Sprayed second time	Sprayed second time	
	28					31 beetles
	30					123 beetles
July	1	141 beetles, considerable feeding	45 beetles	72 beetles, 1 recently dead, considerable feeding	90 beetles, 5 wing cases (representing 3 beetles), 1 hanging dead	41 beetles
	2					33 beetles
	6			None dead	None dead	57 beetles
	7					6 beetles
	14			None dead, few living, 3 egg clusters	None dead, few living, 5 egg clusters	8 beetles
	21	Fewer beetles than in 2, 3 or 4 and fewer eggs than in 3 or 4	Beetles more numerous than in 3 or 4, less feeding than in 1, 3 or 4	6 egg clusters and more beetles and more feeding than in 4	Very few beetles, 6 small and 5 fair sized egg clusters	13 beetles
Aug.	1	7 beetles	1 beetle	None	None	2 beetles
	18	None	None	None	None	No beetles. Total 511

It will be seen, on comparison between the cage in which cultivation occurred and the number of beetles observed in cages 1, 3, 4 and 5, that a large proportion of the insects must have been destroyed by this means. In all probability over 50% and possibly 75% or even more, were killed by cultivation, because we find that on July 1 there were 141 beetles in cage 1, and in cages 3 and 4, which should be added together as each contains but a vine, there were 162, while in cage 5 we had obtained at that time nearly 400 insects. In cages 3 and 4, it will be observed that there were 72 and 90 beetles respectively living July 1, 12 days after the first application of poison. One dead insect was found in cage 3 and five wing cases, representing three individuals, and another hanging in cage 4. The conditions, however, in these two cages, as compared with the others at the same time, were so similar that we could not be certain that the relatively few insects found dead had been killed by poison, and the same was true on July 6, 14 and subsequent dates. A study of the record of captures in cage 5 showed that a very large proportion, 92%, of the beetles appeared above ground within two weeks after the first insects were observed abroad. In other words, we bred from the soil about two vines 511 beetles, 477 appearing in the first two weeks.

The experimental vineyard,[1] which was selected only after extensive examinations in different vineyards in the Chautauqua grape belt, appeared to be a place where the insects were rather abundant and yet had not caused very serious injury unless it was in the immediate vicinity of the cages. The plot selected

[1] The cultivation of this vineyard is of interest, and data relating thereto, kindly placed at my disposal by Mr Falvay, is as follows: Ap. 28 the vineyard was gang-plowed, and was horse-hoed the 30th; May 4 it was hoed by hand; May 7 harrowed with a spring-tooth harrow; May 11, 350 pounds of kainit to an acre applied; May 14,* one furrow on each side of the row was turned toward the vines; May 22, the space between the furrows was cultivated; June 5,* horse-hoed for Fidia, following with the cultivator; June 16, cultivated for Fidia. Each process required about a day, and the cost for 5 acres was placed at $27. The additional cultivation (*) for Fidia amounted to $8.50. The vineyard since Aug. 1, in addition to that given above, has been gang-plowed, harrowed with a spring-tooth harrow and cultivated, each operation twice in a row and one after the other and followed by cultivation with an acme harrow. The vineyard is showing the effects of good treatment and has developed a very satisfactory amount of wood in spite of previous root worm injury.

was the portion just south of Mr Falvay's packing house, extending over a gravelly knoll into a loamy hollow. The region next to the packing house contained comparatively few insects, which was probably due in considerable measure to a neighbor's chickens working in that section. The first 24 rows south of the packing house were reserved largely for demonstrating the effectiveness of collecting, and no cultivation for the destruction of pupae was allowed on its six southern rows and also on the next six rows of the adjacent plot. The next plot of 13 rows was sprayed with arsenate of lead, 5 pounds to 50 gallons of water. The application was made July 26 and special pains were taken to cover the vines as thoroughly as possible. The 11 rows south of the arsenate of lead plot were sprayed the same day and in the same manner with poisoned bordeaux mixture, 6 pounds of copper sulfate, 6 pounds of lime and ¼ pound of paris green being used to 40 gallons of water. The next two rows were not sprayed, but were left as checks, and the following 11, namely those just north of the cage except one, were sprayed with an arsenate of lead mixture as described above. The spraying with poisoned bordeaux was thorough, though not quite so carefully done as in the case of the arsenate of lead. At the time the application was made there was a considerable evidence of feeding in the section next the cages and also in that sprayed with the poisoned bordeaux mixture. The row just north of the cage and that on which the cages stood received no poison.

Insects taken by the beetle catcher. The operation of the beetle catcher over 5 acres resulted not only in capturing a large number of Fidias but also in taking a number of other species. The list is of interest because it indicates in a measure the excellent cultivation and care which this vineyard has received. It will be observed that no species appeared in any numbers compared with those of Fidia, which fact alone is of considerable value in indicating the care and clean culture given the vineyard. A few caterpillars and other soft bodied larvae were taken but in relatively no larger numbers, and no attempt was made to count them. The list follows, and it will be seen that the number taken of any species is so small that practically all may be neglected, as regards either beneficial or injurious powers.

NUMBER OF VARIOUS INSECTS TAKEN IN BEETLE CATCHER

COLEOPTERA

1 Calathus gregarius *Say*, July 7, 14, 26
1 Bradycellus rupestris *Say*, June 26
2 Megilla maculata *DeG.*, spotted lady bug, July 7
1 Coccinella 9-notata *Hbst.*, nine spotted lady bug, June 26, July 7
1 Chilocorus bivulnerus *Muls.*, twice stabbed lady bug, June 26
10 Brachyacantha ursina *Fabr.*, June 26, July 7
2 Tenebrioides corticalis *Melsh.*, June 26
1 Melanotus communis *Gyll.*, June 26
2 Asa hes baridius *Say*, June 26
2 Pyropyga nigricans *Say*, June 26, July 7
1 Telephorus carolinus *Fab.*, June 26
1 Hydnocera *sp.*, June 26
1 Macrodactylus subspinosus *Fab.*, rose beetle, June 26
1 Pelidnota punctata *Linn.*, spotted grapevine beetle, July 1, 14
1 Xylotrechus colonus *Fab.*, July 1
1 Euderces picipes *Fab.*, July 14
1 Eupogonius tomentosus *Hald.*, June 26
1 Doryphora 10-lineata *Say*, July 14
1 Disonycha xanthomelaena *Dalm.*, June 26
6 Haltica chalybea *Ill.*, steely flea beetle, June 26, July 14
1 Crepidodera helxines *Linn.*, June 26
1 Doryphora clivicollis *Kirby*, June 26
4 Systena taeniata *Say*, pale striped flea beetle, June 26
1 Notoxus monodon *Fab.*, June 26
20 Otiorhynchus ovatus *Linn.*, ovate snout beetle, June 26
1 Phytonomus punctatus *Fab.*, punctured clover leaf weevil, July 1
1 Conotrachelus nenuphar *Hbst.*, plum curculio, June 26
1 Hylobius pales *Hbst.*, Pales weevil, July 7

HEMIPTERA

1 Canthophorus cinctus Beauv., July 14
1 Euschistus tristigmus *Say*, July 1
1 Nezara hilaris *Say*, July 1, 7
8 Lygus pratensis *Linn.*, tarnished plant bug, July 14
1 Thamnotettix clitellaria *Say*, June 26

Observations showed that the red-headed flea beetle, Systena frontalis Fab., was somewhat abundant in Sheridan vineyards July 21 and relatively much more so than in and about Westfield, where most of our experimental work was done.

Food plants. This beetle has a comparatively restricted food habit. It was early observed by Mr Walsh on grapevines, and the late Professor Riley recorded its feeding on the American redbud, Cercis canadensis. It is also known to feed on the native Virginia creeper, Ampelopsis quinquefolia.

Varieties affected. The Concord, as is well known, is almost universally grown in the Chautauqua region, and consequently is one that has suffered to the greatest extent from injuries by this pest, though our observations convince us that the Niagara is even more liable to injury, and in the cases we have seen the difference was quite marked. Referring to Ohio reports, it will be seen that Mr Maxwell states that Wordens and Brightons were killed first, while Concords and Catawbas were not so badly in-

jured, and in a later report he states that renewing a vineyard with Niagara vines seems to be quite a success. This latter point, we think, needs further demonstration. On the other hand it will be observed that Mr Slade considers that the Wordens and Catawbas suffer more than the Concords. The relative liability of different varieties to injury is probably influenced to a considerable extent by location and character of the soil, specially the latter, and it is therefore not surprising to meet with some discrepancies as to the relative amount of injury they suffer. Extended observations and probably careful experiments are necessary before authoritative conclusions can be reached.

GRAPEBERRY MOTH
(Polychrosis botrana Schiff.)

This species is present in more or less numbers in most vineyards, and as it was met with in the course of our experimental work on Fidia, and since this latter gave some valuable results on methods of controlling this fruit pest, a brief notice of it is included. This species is specially destructive in the vicinity of forests or in vineyards near which bushes of various kinds, particularly sumac, are allowed to grow. It is believed to have two generations in this country, the larvae of the first feeding on the blossoms and those of the second in the fruit. There is possibly a third brood. It is gratifying to state that we have obtained excellent results in controlling this pest with arsenate of lead and also the poisoned Bordeaux mixture. The spraying, done shortly after blossoming and while the fruit was not larger than a small pea, was primarily for the purpose of killing Fidias; but investigation this fall shows that it was much more effective in destroying young of the grapeberry moth, since there is certainly 50% less damage to fruit on sprayed than on unsprayed rows, even when the two are side by side. The difference was so marked that it was easily observed, and in walking between the treated and untreated areas, it was not hard to find infested clusters on the one side while on the other they were much less abundant. It was also observed that not only was this insect checked by spraying but the foliage was benefited by the treatment, having a better color and remaining on the vines a longer time.

Our experiments were in Mr D. K. Falvay's vineyard, and he informs us that last year a section of six or seven rows in his

vineyard next to a lot of sumac and other bushes, was so badly infested by this worm, that no attempt was made to pick it. The wild growth was cut away last winter and burned, and the fruit on these rows was no more infested this year than that of any other section of the vineyard.

We therefore advise clean culture, specially the destruction of bordering hedges and adjacent miscellaneous forest growths and the burning of debris in a vineyard, in order to lessen shelters where the insect may pass the winter. It is advisable to locate vineyards when possible at some distance from woods, and whereever they are infested to any extent by this pest, spray with an arsenical at least once after blossoming.

NATURAL ENEMIES

This serious grapevine pest is subject to attack by several natural enemies. Two interesting species of egg parasites, bearing the scientific names Fidiobia flavipes Ashm. and Brachysticha fidiae Ashm., were bred from eggs of this insect by Professor Webster in 1894, and in 1896 he expressed the belief that a marked decrease in numbers of the Fidia was possibly due to the work of these parasites. Professor Webster also observed a small brown ant, Lasius brunneus var. alienus, feeding on the eggs, and a small mite, provisionally identified for Professor Webster by Dr George Marx, as Tyroglyphus phylloxerae P. & R., extracting the contents of several eggs in succession, and also a smaller mite resembling Hoplophora arctata Riley. Another mite, Heteropus ventricosus Newport, was met with by Professor Webster in 1896 who credits it with being quite destructive to the eggs of this pest. One of these small mites, probably a species of Tyroglyphus, was observed in our breeding cages feeding on the pupae, one being almost entirely destroyed.

Several predaceous insects were found by us during field work, specially when digging for larvae in the early spring. The grubs of some carabid beetle were observed to be about two thirds as numerous as those of Fidia during the last of April, and it is very probable that they prey on this species. We were unable to bring any of the carabids to maturity. A small beetle, Staphylinus vulpinus Nordm., was associated

with Fidia grubs and possibly preys on them. The larva of an aphis lion, Chrysopa species, was observed by the writer investigating under loose bark where eggs were present, and it is not at all improbable that these insects destroy many.

REMEDIAL MEASURES

It was felt when this study was undertaken that there was a lack of definite knowledge regarding methods of controlling this insect and it was accordingly planned to make a thorough test of those advised as well as to experiment in other directions. Some of these investigations gave results which appear to have a positive value, while others only proved certain measures comparatively useless.

Destroying the pupae. There is no doubt as to the benefits of cultivating vineyards for the purpose of destroying the pupae, if the operations are properly carried out. In the first place, plan to have a moderately high ridge of firm earth about the base of the vines the latter part of May, so that the grubs will come well above the roots before transforming to the pupal or "turtle" stage. Then adjust operations so that horse-hoeing away from the vines will come early in June, thus avoiding special cultivation for the purpose of destroying the insects. It may be found, however, that some adjustment of the cultivator, so that it will work a little deeper, or a little extra care in keeping the implement close to the vine, will materially increase the efficiency of this operation. In 1902 our attention was called in the early part of June to a vineyard where there were from 50 to 60 grubs about many of the vines, while repeated search the latter part of the same month failed to discover more than three or four pupae under a vine and in many cases not a specimen. In the interval this vineyard had been carefully cultivated for the purpose of destroying the pupae, and we are of the opinion that this practice was largely responsible for the scarcity of the insects. This is further substantiated by our cage experiments in 1903 [*see* p. 27] which show that from 50% to 75% or more of the pupae can be killed by cultivation no more thorough than that given by horse implements. These data lead us to believe that much can be accomplished by planning cultural operations so that the vineyard will be horse-hoed at the time when the majority of the insects

are in the pupal or "turtle" stage. This operation may well be deferred till some of the more advanced insects begin to brown a little or even till a very few have changed to beetles, and its efficiency can be further enhanced by repeating the cultivation, with a spring-toothed harrow, about a week or 10 days after in order to catch some of the later transforming individuals. There may be a difference of a week or more in the development of the insects in a vineyard, and this means that each grower should know the pupa and watch for its appearance. This variation is due largely to the character of the soils, as some warm up much more rapidly than others, and the final changes to beetles occur correspondingly quick.

Collecting beetles. This method of controlling the grapevine root worm did not promise much when it was first attempted. Professor Webster had either not considered it worth trying or had found it of comparatively little value, and Dr Marlatt did not even mention it in his recommendations. Professor Slingerland made the guarded statement in 1902 that it may be practicable in some cases to jar the beetles into a collecting apparatus, but he apparently had little faith in the plan, except when the insects could be jarred to the ground where they would be eaten by chickens.

Mr J. J. Barden, working under the writer's directions in 1902, found that, even with a plain cloth-covered frame several feet square and with a small slit in one side, so that it could be slipped under a vine, large numbers of the insects could be collected. With this crude apparatus he was able to capture a quart of beetles in about two hours. This indicated that much better results could be secured with a more elaborate apparatus; and with the aid of Mr G. L. Hough he constructed a modified form of the Curculio catcher, which is represented on plate 9. The machine is 6 feet long and 3 feet wide at the top, with vertical ends and the sides sloping to a trough about 3x3x72 inches. A central slit about 3 inches wide was cut in the side opposite the handles and the whole mounted on a two wheeled frame. The long trough is subdivided by a few transverse partitions, and these spaces are partly filled with kerosene and water. The sides, ends and trough are constructed of galvanized iron and strengthened with iron straps as shown in the figure. The

wheels are from a toy cart and the handles and frame are homemade. The method of operation is simply to wheel the machine between the rows, and then, elevating the handles, to slip the farther side under the wire, and the trunk of the vine entering the slit permits the placing of the machine directly under the vine. It then remains for the operator to jar the insects off. Mr Barden found that it required several shakings to dislodge all the beetles. In one case he succeeded in catching 64 by jarring a vine once. It was found advantageous to have three machines operating together and placed simultaneously under adjacent vines. This arrangement facilitated the work very greatly and reduced to a minimum the beetles jarred from vines before a machine could be placed under them.

This method appealed so strongly to Mr Hough, who by the way is a very practical business man, that he used it daily for a time on certain badly infested vines, and found that, in the case of the third jarring, he did not get over three or four beetles to a vine, whereas at the first operation 40 to 50 were secured and 15 or 20 at the second jarring. An examination in this vineyard July 24 showed that the beetles were not nearly so abundant as two weeks before, largely due to four collectings in two weeks. The Hough beetle catcher was further tested in 1903, with the result that 1343 beetles were taken June 26 from approximately 110 vines, or an average of over 12 to a vine. The principal difficulty with this device is the relatively large amount of time consumed in placing it under a vine and making the necessary jarrings.

Collecting beetles, if rapidly done, appeared to be a feasible method of checking this pest and our plans contemplated a rigid test of its possibilities in 1903. Mr F. A. Morehouse of Ripley designed an improved form of catcher, the essential idea of which is continual motion and jarring. We arranged to have one built and thoroughly tested, believing the situation justified the experiment, and the results have been most gratifying. This machine, illustrated on plates 10, 11, 12, is essentially a pair of troughs on wheels and is drawn through the vineyard astride the row. The troughs are connected over the vine by bracing arms and wires (placed high enough to clear all posts) and are hung by ½ inch iron rods, which permit the side

springs to push the troughs under the vines so that their inner edges are close to the stems or posts as the case may be. The outer slope of each trough is a 3 foot strip of oilcloth stretched over a frame, while the inner is a 10 inch rubber belt 11 feet long. These sloping sides guide the insects so that they fall into the eaves trough, which is divided into small sections by a number of water-tight compartments each of which contains a quantity of water with a small amount of kerosene floating on its surface. The whole machine, as will be seen by the illustrations, is a home-made affair, and was built simply to test the practicability of the idea. The dimensions are as follows: length 12 feet, width 5 feet, hight 7½ feet, length of trough 11 feet, of runners for same 12 feet, diameter of wheels 2½ feet. It can undoubtedly be made considerably more efficient; the troughs, for example, should be broader in order to accommodate more insects and debris. The common wooden springs could be replaced by steel ones and the rough wooden wheels by well made wooden or iron ones, and, instead of being on a fixed axle, it would be a decided advantage if they were on a swivel axle. All these improvements can be easily made later in case the machine commends itself to growers. This device was drawn over two rows of approximately 120 vines and took therefrom 1583 beetles, or an average of about 13 to a vine. This was at a time when not over 17 could be counted on a vine, though there were probably more. The entire operation consumed less than 20 minutes, and, somewhat to our surprise, the efficiency of the machine appears to be a little higher than that of the Hough beetle catcher. It was also operated over nine other rows and 3300 beetles secured, an average of about six to a vine. These rows were not quite so badly infested as the two mentioned above. The record of collecting with this machine, in addition to that above, is of interest and is given herewith.

July 2, 2650 beetles were taken from two check rows, which were in reality but one and one half rows, owing to many of the vines being very small and some missing. June 30 and July 1, 72,000 beetles were captured with this machine from all the experimental plots. July 7, 34,550 and July 14, 8380. Comparing the last three catchings, which were all from the entire area, it will be seen that there is a decrease of over 50% between the catch of July 1 and 7 and that the catch of the 14th was less

than 25% of the catch on the 7th. About 154,900 beetles were taken from this area of approximately 5 acres, 3 of which were much less infested than the 2 next the experimental cages. This means that an average of 59 beetles was secured from each vine in spite of the fact that a considerable proportion of the area had been previously cultivated for the special purpose of destroying the pupae. These figures give some idea of the immense number of insects which must have been in the vineyard when work was begun last spring.

As further evidence of the value of collecting for this insect, it may be interesting to state that last spring, sample diggings under different vines in the experimental area, gave from 8 to 50 or more grubs or as calculated from 60 to 400 or more to a vine, in one case it was estimated that there were fully 1000 under a single vine. Sample diggings in October resulted in obtaining no grubs from three vines, one only from each of three, and two only from two others, indicating that there were very few which had more than 12 or 15 grubs, and that, in all probability, the number to each vine would hardly exceed eight or nine. In other words, cultivating and collecting in one season reduced the number of grubs about 98%. These figures are sufficiently striking, so that no further comment is necessary on the efficiency of collecting and destroying the beetles; in fact, this vineyard after one season's work may be considered more free from the pest than almost any other in that section, and it will compare very favorably with those in places where Fidia has caused practically no injury.

Our experience with collectors has demonstrated the practicability of catching the beetles, and we recommend this operation for all badly infested sections, and that the collecting be begun as soon as the beetles appear on the vines in any number, say, when there are 12 or 15 on one. The operation should then be repeated at intervals of five to seven days till the vines have been gone over two, three and possibly four times, dependent somewhat on the number of insects which are captured. It will be found that it is much easier to catch the beetles on warm days, when it should be done, than in cool weather.

It may be added that the efficacy of a machine of this character could be materially increased by the adoption of various devices which would tend to lessen the open spaces under the vines and to increase the length of the catching surface. It is interesting in this connection to note that vineyardists in Missouri have been resorting to various catching devices for the protection of their vines from this pest. Many of them employ simple sheets and jar the beetles on them, while others are using a wheelbarrow arrangement on the suggestion of Professor Stedman.

Mr R. S. Blowers, of Portland, after examining the work of our beetle catcher at Westfield, constructed a very effective and cheap device [pl. 13], which is at least worthy of illustration and comment in this connection.

Its essential features are two long frame troughs covered with oilcloth, which hangs over an eaves trough divided into watertight compartments, as in the ordinary catcher. These two sections are each 24 feet long, the outer edge about 3 feet high, while the inner edge is approximately 18 inches high, and each is braced so that a man can pick it up at the center and move it toward or away from the vines. The original plan was to carry it through the vineyard and place it between the posts, jarring the vines and continuing in this manner. This was found rather laborious, and the work was made lighter by the construction of a pair of low bobsleds, fastened together by wires so that each was about 6 feet from the end of the trough, which at this point was provided with a transverse broad base so that it would rest on the bob without tipping. The inner edge of each bob was also provided with a small roll, so that the operator, by tipping the trough slightly toward the row, could roll the entire structure under the vines and, after jarring was completed, could roll it back. A horse was used to draw each half of the collector, and in this way about 3 acres a day could be gone over. This collector has the advantage of being comparatively cheap, since the outside expense for it would not exceed $9 for each half, or a total of $18. Most of the material, except the oilcloth, can usually be found around a farm, and the actual outlay, if the vineyardist made it himself, would be very little.

The late Prof. C. V. Riley, in his report for 1868, calls attention to the fact that one man whose vineyards were very badly infested by this insect had trained his chickens to go between the vines and pick up the beetles as they were dislodged by jarring. Mr F. A. Morehouse of Ripley, who has many chickens in the near vicinity of his vineyard, has practised the same thing with excellent results. The only trouble is that this method has a comparatively limited application, since it is not always practical to have chickens in large vineyards.

Arsenical poisons. A number of experiments were tried with arsenical poisons in 1902 for the purpose of ascertaining their efficiency in controlling this species. Two brands of arsenate of lead and paris green were used. Breeding cage experiments with arsenate of lead, using 2 pounds to 50 gallons of water, showed that seven days were required to kill 9 out of 10 beetles, and that, when 4 pounds of the poison were used to the same amount of water, all of the insects were killed within eight days. The spraying in both instances occurred July 5, and the record is as follows:

2 POUNDS OF ARSENATE OF LEAD TO 50 GALLONS OF WATER

July 7, 6 beetles dead	July 10, another beetle dead
3 alive	July 11 "
1 missing	July 12 "

4 POUNDS ARSENATE OF LEAD TO 50 GALLONS OF WATER

July 7, 4 beetles dead	July 10, another dead
July 9, 4 more dead	July 13 "

It will be seen by examining the above records that in the case of the first over half were killed within 48 hours after the spraying, and in the second less than half within 48 hours and four fifths within four days. It should be added that in the above experiments the leaves were sprayed very thoroughly and the poison allowed to dry before the treated foliage was placed in the cage.

The breeding cage experiments with paris green were less successful than those with arsenate of lead, and, though in one experiment 20% of the beetles were killed within 48 hours after

spraying the leaves with 1 pound of the poison and 1 pound of lime to 100 gallons of water, and 40% more died within four days after the spraying, the general results were not at all satisfactory, and the reason therefor can not be given.

The breeding cage experiments with arsenate of lead would lead one to expect most excellent results in the field, but such was not the case last year, though this may have been due to the fact that the spraying was done shortly before considerable rain fell, and was followed by nearly daily precipitations. The initial application was made July 8, 1902, and repeated the 9th, the rain of the preceding day making it advisable to go over the entire field a second time. The ground at the time the spraying was done was so wet that it was almost impossible to drive a team slowly enough to do good work. Careful search in the vineyard eight days after failed to reveal a single dead beetle. July 31 there were plenty of beetles and many eggs in Mr Northrop's vineyard, where the vines had been sprayed. The necessity of two sprayings resulted in the application of considerable poison, and about five weeks after the treatment it was seen that the sprayed vines had developed very little new growth as compared with untreated ones. There was no perceptible burning, yet the edges of the leaves were somewhat crumpled, and it is very probable that the poison checked the development of the more tender shoots.

The breeding cage experiments in 1902 led us to expect excellent results in the field, and our not obtaining the same after making two applications was attributed largely to the excessively wet weather, which not only washed off the poison but interfered with work in the vineyard. Similar experiments in 1903 gave even less satisfactory results than the year before. It required nine days to kill three out of five beetles. Arsenate of lead and poisoned bordeaux mixture were severely tested in caged outdoor vines, as detailed on page 26, 27. It will be seen by consulting the record that, though the vines were sprayed thoroughly on both June 19 and 27, there were fully as many living beetles on both July 1, 13 days after the first application, as on the two vines in the check cage, and the same was true July 21. Careful observation, during the remainder of the

period when beetles were to be found in cages, failed to disclose any substantial difference between the insects on the poisoned vines and those on the untreated ones. These cage experiments were further supplemented, as detailed on page 29, by extensive spraying. This was done June 25, and July 1 no difference could be detected between the sprayed and the unsprayed vines. This, in connection with our cage experiments, led us to abandon reluctantly further outdoor tests, and the poisoned areas were collected over in order to prevent what we deemed would be an extensive deposition of eggs. In other words, no experiments, other than those confined to small tumblers where the beetles could obtain absolutely nothing except poisoned foliage, gave results which are at all decisive. The reasons for this are several: the beetles do not succumb readily to poison, and being more or less secretive by nature, feed to a considerable extent on under leaves and in concealed situations where it is difficult to throw the spray. In addition they have a marked tendency to feed on the more tender leaves, which at the time spraying should be done appear almost daily on vigorous vines. These factors make it very difficult to control the insect.

The most decisive results obtained with an arsenical spray are those published by Mr John W. Spencer of Westfield, in the issue of the *Grape Belt* for July 24, 1903, in which he gives some definite figures in favor of spraying. Our only regret in this connection is that his experiments were not conducted on rapidly growing vines, because in our judgment these need protection much more than those in poor condition and on which the insects, as previously pointed out, can not be controlled nearly so readily.

Several vineyardists sprayed their vines in 1903 for the purpose of controlling this insect, and as it was stated by various growers that the poison applications had been successful, at their request these vineyards were inspected by us the first week in October, and much to our regret, we found that the reported good results were more apparent than real.

An examination in the vineyard of Mr Frank Monfort, of Brocton, resulted in finding 5, 45, 10 and 9 grubs respectively under as many Concord vines. The first record relates to a

vine which had very poorly developed roots, and consequently was not a fair sample of conditions in the vineyard. Mr Monfort not only sprayed his vineyard twice with a power sprayer, making the first application at the time the beetles appeared and the second a week later, but went to the additional trouble of going over the entire area carefully with a hand pump for the purpose of spraying any which the machine might have missed. He certainly tried to do a thorough job, and yet sample diggings in an adjacent vineyard belonging to Mr Morse gave respectively 3, 6, 3, 6, 16 and 9 grubs under different vines. The two latter records could hardly be compared with those in Mr Monfort's vineyard because they were fully ¼ mile distant and relate to vines which were much more healthy and vigorous. It may be claimed that this is not a fair test of the poison and to a certain extent this is true, yet these are results obtained by a practical man in an earnest effort to reduce the pest, and as they agree with our own experience are not without value. The difference between 75 and 150 grubs under a vine, and 5 to 12 or thereabouts, represents in our mind the relative efficiency of collecting and poison sprays, and our judgment is that these figures mark the difference between protection and serious injury.

The evidence concerning the efficacy of poisons in Ohio, as pointed out on a preceding page, is somewhat contradictory. Reporting on work done in 1899 Professor Webster states that an examination of sprayed fields showed nothing to indicate that arsenate of lead would not prove entirely effective. This differs from some later experiments performed under his direction by Messrs Newell and Burgess, the unpublished records of which through the kindness of Prof. P. J. Parrott have been placed at my disposal. The summary of this later work is as follows:

"Where beetles were abundant last year and vines seemingly badly injured and the arsenate of lead or disparene used this year (1900) few vines have died and all appear in a more healthy condition, but this is true also where none of these insecticides were used, beetles appearing later and in less numbers than for several years." Professor Webster, at the writer's request, has commented on the above experiments as follows. He states that

early results, though satisfactory, were not thought by him to be conclusive, and that a marked decrease in the number of the beetles vitiated later experiments to some extent, so that he did not consider them as either conclusive in themselves or as disproving the earlier work of Mr Mally. He states that arsenate of lead must be tried thoroughly several times where conditions are such as to enable one to obtain decisive results either one way or the other before it will be safe to make definite statements. Professor Stinson reports only fair success in destroying the beetles with poisons in Arkansas.

It seems very probable, therefore, that some of the Ohio growers have been led to attribute the relative scarcity of these beetles to the use of poison whereas it may have been due almost entirely to natural conditions.

Mr T. S. Clymonts states that in his experience spraying with bordeaux mixture has proved of some benefit, since the beetles prefer untreated vines and will migrate to them if near by.

Mr J. W. Maxwell, Euclid O., writing under date of Aug. 29, 1903, states that he called Prof. F. M. Webster's attention to the insect in 1893 and adds that in all his experience, now extending over a decade, he has not found a poison that will "exterminate" the insects, or, in other words, that has given satisfactory results.

Prof. F. M. Webster has recently called our attention to a case in Bloomington Ill., where the owner of a badly infested vineyard, began spraying thoroughly with arsenate of lead. He says that the vineyard at the outset was in very poor shape, that now it is returning to somewhere near its normal condition, and that he fails to find the slightest indication of beetles except on one or two vines. This has been accomplished within two or three years; and the owner, Mr J. L. Lampe, attributes it to the use of the insecticide, with which Professor Webster is inclined to coincide. Our experience with the pest suggests that possibly many of the insects may have forsaken this vineyard because of its poor foliage and gone to others where there was better shelter, and that therefore the protection afforded by the arsenate of lead may have been overestimated. In a later communication, Professor Webster states that he has found great numbers of dead beetles under sprayed vines and none under those

free from poison, a fact that shows that some protection is afforded. This, however, was in a vineyard which had been seriously injured and was therefore not making much growth.

We have been to considerable pains in looking up evidence both for and against arsenical poisons and the above summary of results obtained in Ohio, in connection with the work done in New York and elsewhere, leads us to the conclusion that, while the arsenical spray may, under certain conditions, give some protection from this insect, either by driving away the beetles or possibly killing them, we are by no means certain that this will result, specially in the case of more thrifty vineyards, and we are inclined to believe that in some instances the benefits resulting from poison applications have been greatly overestimated. We do know, on the other hand, that collecting and killing the insects, if it be done early enough, means protection, and for the present we prefer to recommend the latter method of fighting the pest rather than to indorse the use of a poison, the general utility of which has not been proved for Fidia. Enough has been done to warrant more extended work with poisons and it may be that another year or two will enable us to determine their true value.

Destruction of the eggs. This seemingly difficult operation was accomplished by Mr William Barden of Ripley by rubbing the canes with a gloved hand. He found that most of the eggs were deposited on the middle shoots, and that the great majority of them were crushed by rubbing. The operation, though slow, is not necessarily very expensive, as a man could go over approximately an acre a day without difficulty.

We have also conducted some experiments to test the resistance of the eggs to insecticides and have learned that a whale oil soap solution, 1 pound to 4 gallons of water, has no effect on them. It is doubtful if they can be destroyed with a spray. The extended period during which eggs are deposited, however, renders Mr Barden's method of controlling the insect of somewhat questionable value, and its employment can be advised only when a vineyard is found to be badly infested with eggs, and there is, therefore, no other method of getting at the insects before the grubs commence their operations.

Pulverizing the soil and mounding. Prof. F. M. Webster, as a result of his studies, advised thorough cultivation of the soil during the hatching period, taking special pains to keep it banked up over the roots. Professor Webster's idea was that the young insects dropping in the dry sand would be quickly destroyed wherever exposed to the sun, that the looseness of the surface layers would prove a serious hindrance to their burrowing, and that the increased depth over the roots would also provide an additional barrier to the grubs. Thorough cultivation is undoubtedly a most excellent thing, and the additional vigor arising therefrom is a valuable asset in enabling the vine to withstand very serious injury. Our experiments on the traveling and burrowing powers of these little grubs, however, lead us to believe that this measure, so far as preventing access to the roots is concerned, is not of much value. This is confirmed somewhat by the experience of Mr T. S. Clymonts, who states that a seriously injured vineyard can be renewed by thorough cultivation, and that he has experienced no difficulty in doing this with flat cultivation. In fact, Mr Clymonts is of the opinion that mounding the earth about the vines is injurious in other ways and therefore does not advise it. He recommends cutting back the vines to the living wood, enriching the land liberally with stable manure and applying about a barrel of salt to the acre. Then he cultivates with a disk harrow or other tool which will not stir the earth to a great depth, since he believes that deep plowing cuts off a large number of roots and is very injurious to the vines. He states that in several cases known to him where this has been done and flat culture adhered to, badly damaged vineyards have been restored to a very satisfactory condition.

Carbon bisulfid. Prof. F. M. Webster instituted some rather extensive experiments with carbon bisulfid against this insect, and the summary of his results is as follows. He found that the substance could not be used to advantage in soil that was very dry or saturated with water, and that it must be used in that which is damp. He states that the most satisfactory results will probably follow its use in the spring, in a damp soil, when it is applied in such a manner as to fumigate the

roots without the fluid coming in contact with them. He recommends from 4 to 6 ounces for each vine and states that it is not possible to kill every worm about a vine, and that it is doubtful if the low price then current for fruit would justify its use. Growers in the vicinity of Cleveland have not used this insecticide to any extent since the time Professor Webster made his experiments, and they give the high cost as the reason for its not being adopted. It should also be added that considerable care is necessary or the vines will be severely injured.

Kerosene emulsion. Several writers have advised killing the grubs at the base of the vines by the use of a kerosene emulsion, which is to be washed to a greater depth by copious watering or subsequent rain. We have seen very few cases where the grubs were congregated sufficiently to warrant any attempt at killing them in this manner, and it hardly appears practical in a large vineyard.

Crude petroleum. It was hoped that it would be possible to destroy the grubs of this pest by the application of this substance to the soil, and there seemed a chance of using it to prevent the young larvae from making their way to the roots. Some experiments in the office, however, demonstrated that the grubs easily penetrated soil which had the surface layers moistened by a fine spray of the oil, specially if placed on the soil 30 minutes to half a day or more after treatment. This substance appears to have very little value in controlling this insect.

Effect of calcium carbid refuse on grubs. Our attention was called to this substance by the statement that it had proved very valuable against the Phylloxera in France. Some of the material was kindly sent us from the Union Carbide Co.'s plant at Niagara Falls, and various experiments with the grubs were tried. One part of this substance mixed with 10 pounds of soil was placed in a box and some grubs added. One was dead the next day after having burrowed about ¼ inch and two others went to the depth respectively of 1¼ and 2 inches. No additional fatalities occurred even after 10 days. Several other experiments gave the same general results, and apparently we can have no hopes of this substance being of value in this particular case.

Recommendations. Apparently no one method can be relied on to control this insect, and our recommendations may be summarized as follows. Plan cultural operations so that a firm ridge of earth may be horse-hoed from the vines or otherwise cultivated or disturbed when the great majority of the insects are in the pupal stage and take special pains to stir the soil thoroughly in the near vicinity of the stem. Thorough cultivation and well enriched soil will do much in aiding the vines to withstand attack. This, supplemented by collecting beetles, particularly with a device which will catch them without the delay incident to stopping at each vine, is advisable on badly infested areas during the first two weeks after the adult insects appear in any numbers. The latter may possibly be supplemented or replaced by thorough spraying with an arsenical poison, preferably arsenate of lead, when the beetles begin to appear. Evidence at hand regarding spraying for this insect is not satisfactory, and for the present we prefer to limit our indorsement to above named methods of known value. We believe that these two courses, intelligently applied, afford a most feasible and thoroughly practical solution of the difficulty.

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1903 **Slingerland, M. V.** Grape Belt, June 19. (Summary of present conditions)

1903 **Spencer, J. W.** Grape Belt. July 24. (Results with arsenate of lead)

EXPLANATION OF PLATES

Plate 1[1]

1 Beetle, much enlarged

2 Leaf badly riddled by the beetle

3 Eggs on last year's wood; the loose bark has been lifted so as to expose them

4 Larva or grub, much enlarged

5 Work of larva or grub on larger roots

6 Pupa or "turtle stage" in cell

7 Same much enlarged

Plate 2

1 Vineyard somewhat injured by Fidia, August 1903

2 Healthy vineyard with vigorous foliage, August 1903

Plate 3

Vineyard badly injured by the grapevine root worm. Observe that very few of the vines extend to the top wire. The wires and posts would ordinarily be concealed in a thrifty vineyard.

Plate 4

Vineyard more seriously infested than the preceding. A portion of this was uprooted last spring, and the area shown was kept simply for experimental purposes.

Plate 5

Portion of two vines represented on the preceding plate and showing how badly the beetles may eat the foliage when abundant.

Plate 6

Leaves from badly eaten vine, illustrating the peculiar, chain-like eaten areas

Plate 7

Breeding cages, distant view, showing also the general condition of the experimental area, June 1903

Plate 8

Breeding cages, near view, showing general condition of the vines near by, June 1903

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[1] Executed from nature under the author's direction by L. H. Joutel.

Plate 9

Beetle catcher devised by Messrs Hough and Barden

Plate 10

Morehouse beetle catcher

Plate 11

Morehouse beetle catcher

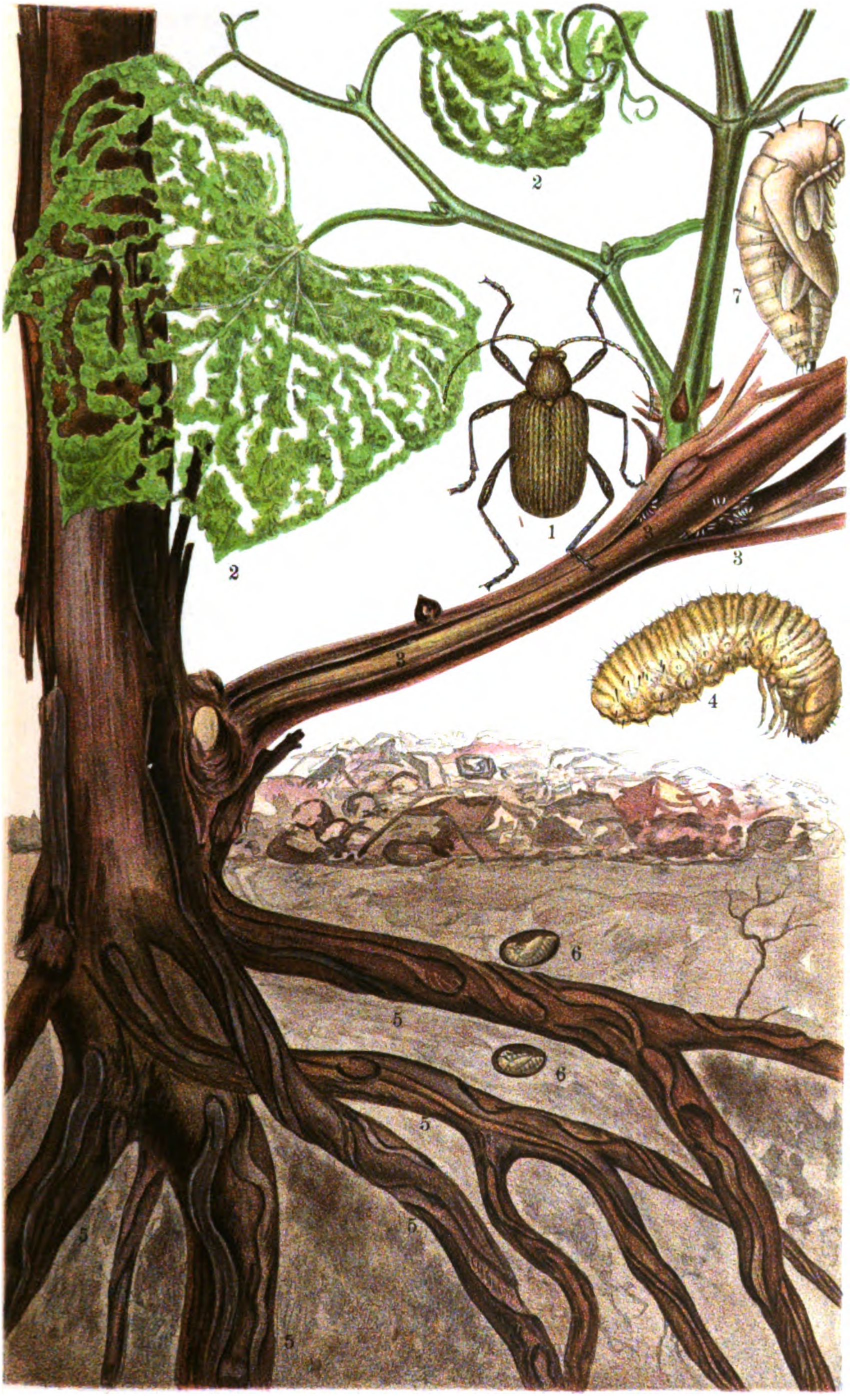
Plate 12

Morehouse beetle catcher in operation, June 30

Plate 13

Blowers collecting machine

Plate 1



L. H. Joutel, 1902

Grapevine root worm

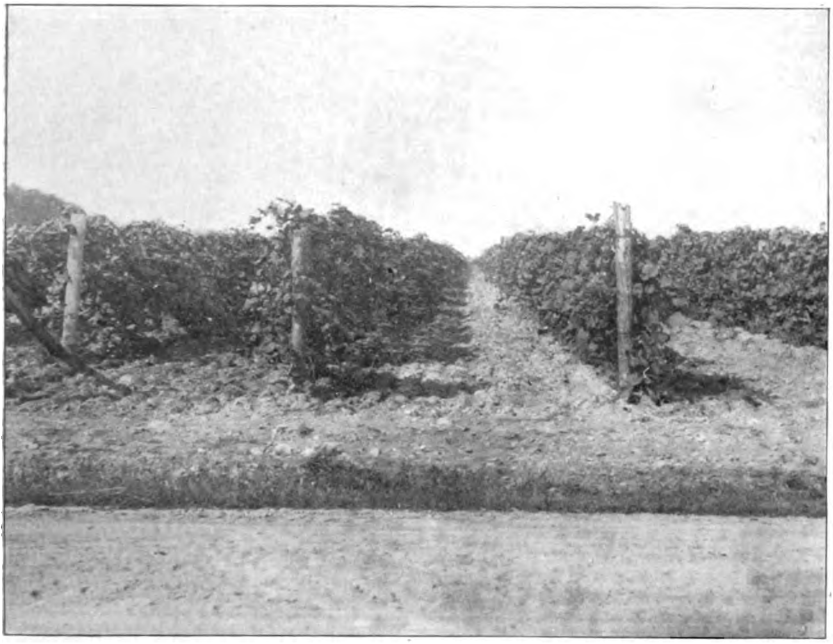


Photo August 1903

1 Vineyard somewhat injured by root worm

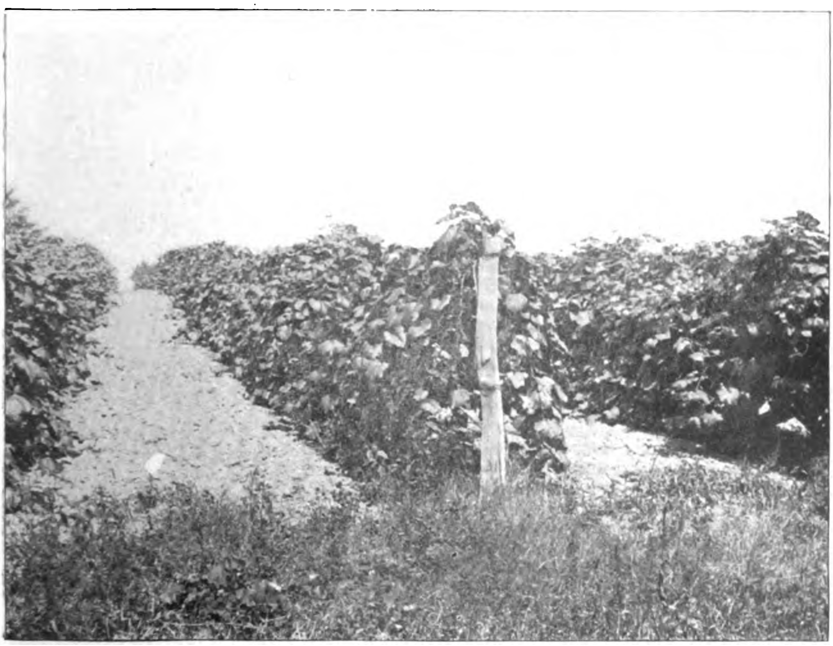


Photo August 1903

2 Healthy vigorous vineyard

Plate 3

Photo Aug. 15, 1902

Vineyard badly injured by grapevine root worm (The vines should cover the wires and posts.)

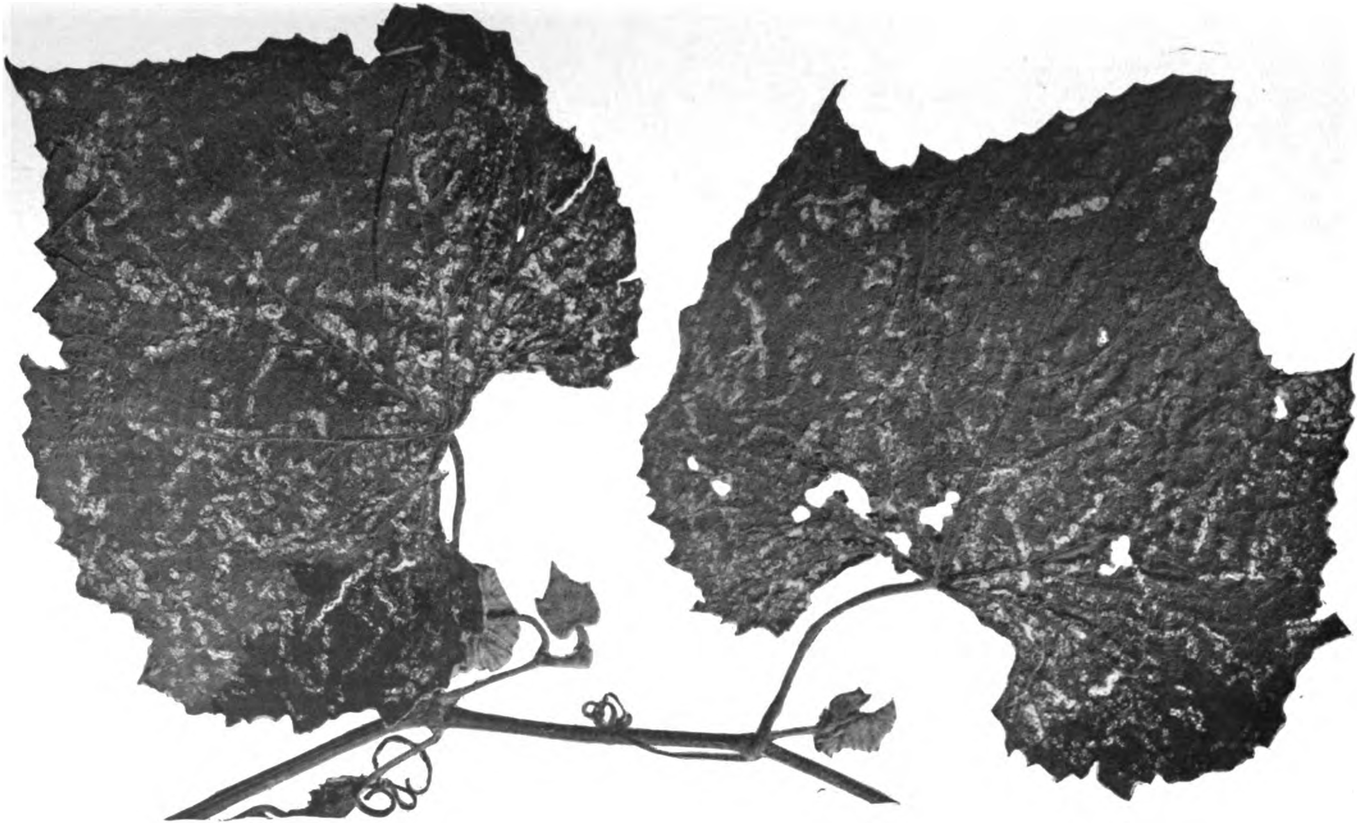
Photo Aug. 15, 1902

Vineyard very badly injured by grapevine root worm (This piece was torn out by the owner as worthless.)

Plate 5

Foliage badly eaten by beetles

Photo Aug. 15, 1902



Leaves from badly eaten vine, illustrating the peculiar chainlike eroded areas

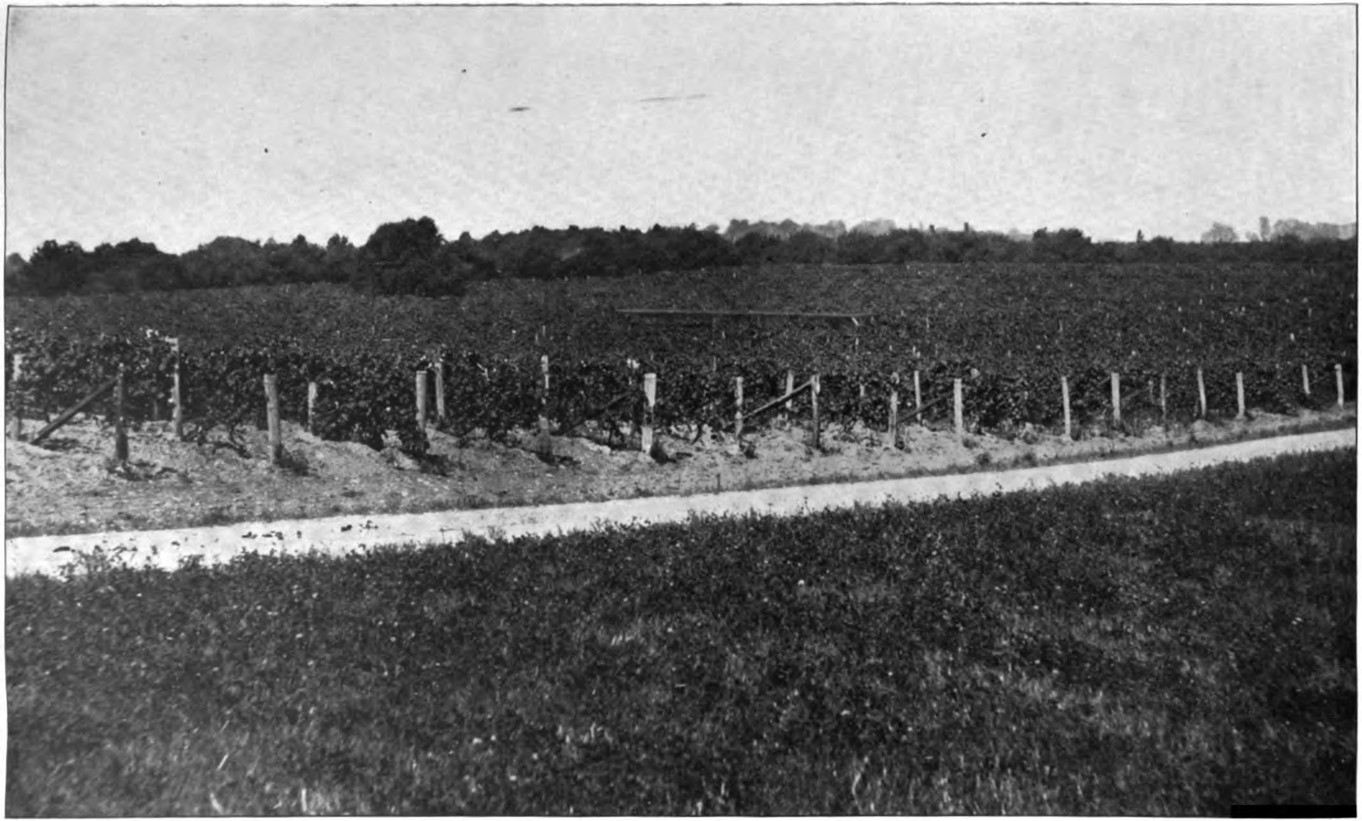


Photo June 1903

Experimental vineyard and breeding cages near center

Plate 8

Photo June, 1903

Nearer view of breeding cages

Plate 9

Photo Aug. 15, 1902

Hough beetle catcher

Plate 10

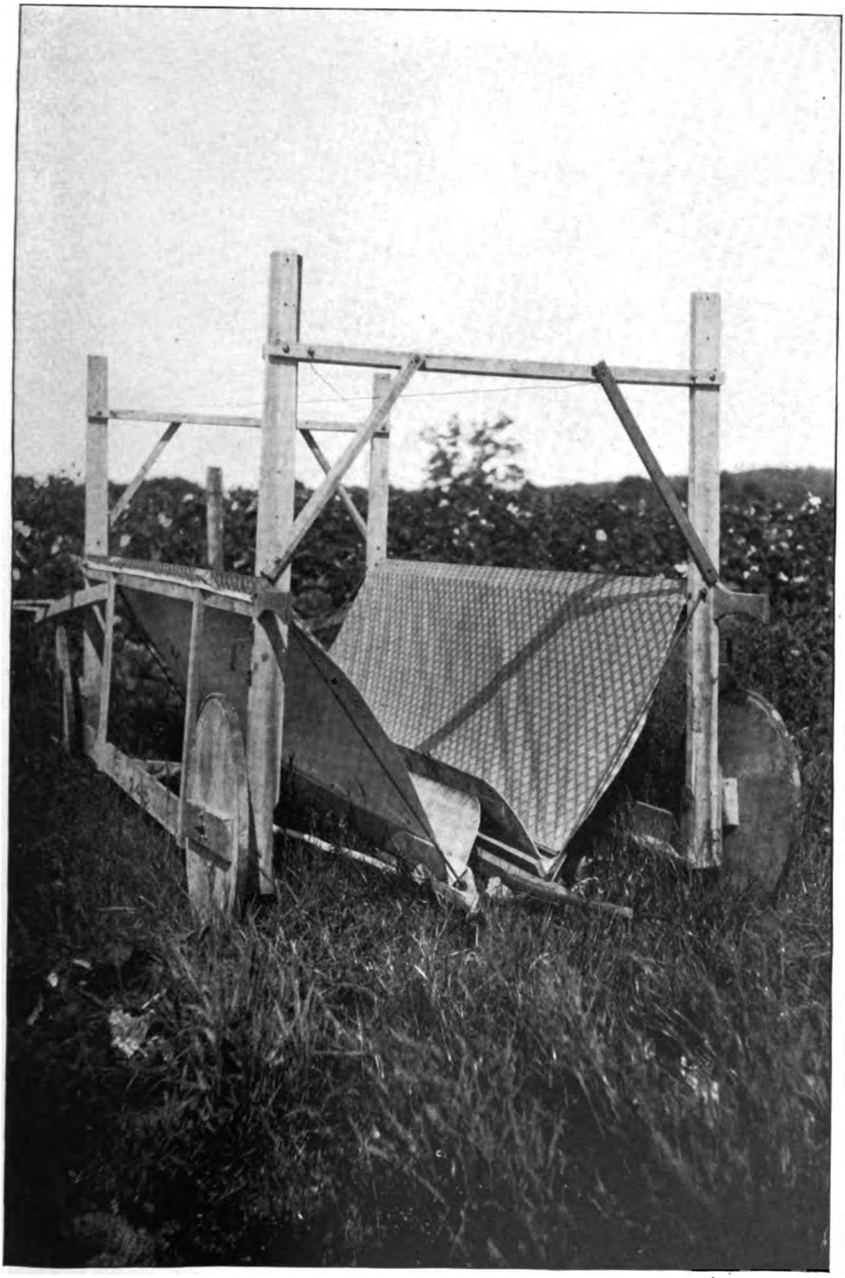


Photo June 1903

Morehouse beetle catcher

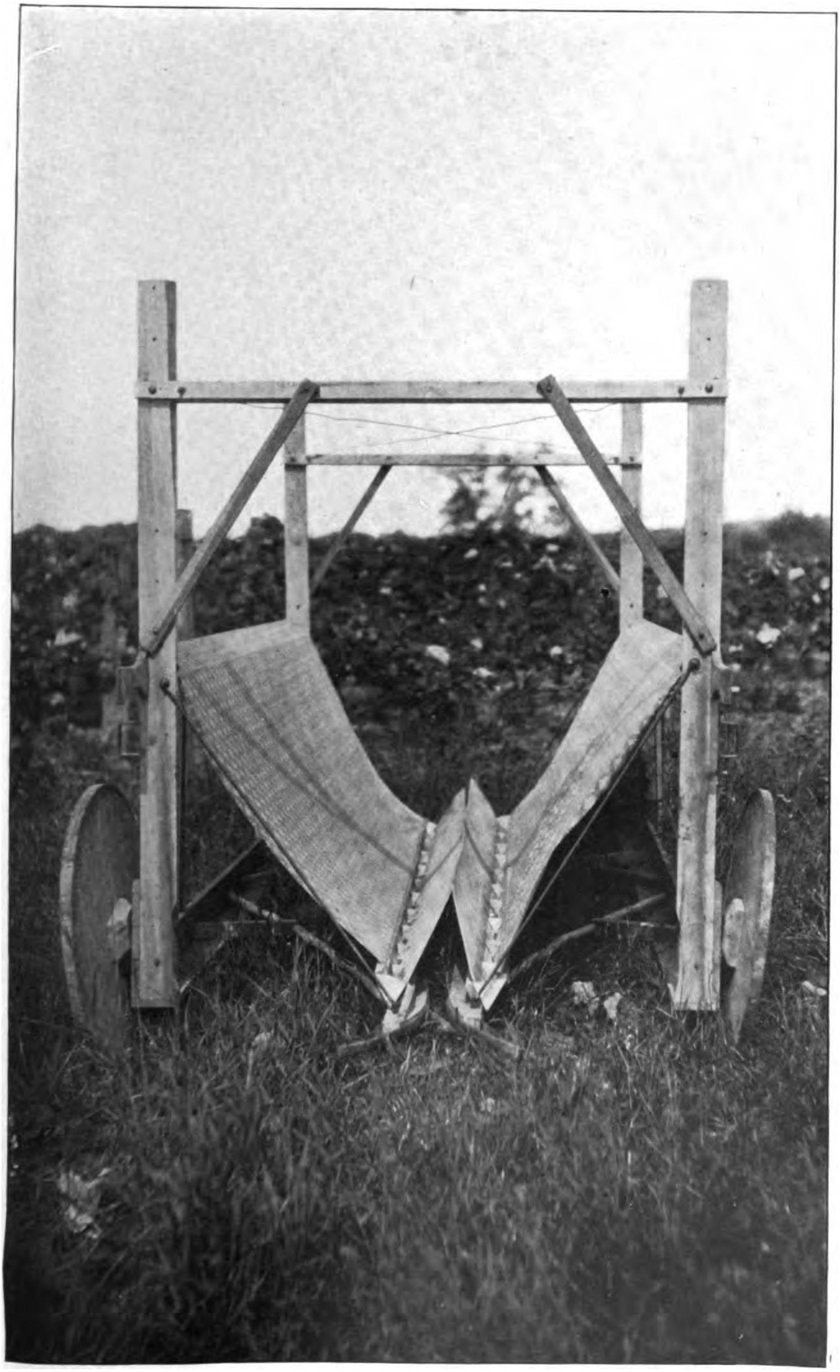


Photo June 1903

Morehouse beetle catcher

Photo June 1903

Morehouse beetle catcher in operation

Photo August 1903

Blowers beetle catcher

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16-17	50 "	26-31	53 "	37-44	" v. 3
18-19	51 "	32-34	54 "	45-48	" v. 4
				49-54	55, v. 1

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New York State Museum

FREDERICK J. H. MERRILL Director

Bulletin 73

ARCHEOLOGY 8

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OF THE
NEW YORK INDIANS

BY

WILLIAM M. BEAUCHAMP S. T. D.

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Bulletin 73

ARCHEOLOGY 8

METALLIC ORNAMENTS

OF THE

NEW YORK INDIANS

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Abbreviations at the left are used in the bulletin in exact reference to works in the following list:

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As there were national and provincial costumes in the countries of Europe, so were there differing fashions of dress and ornaments among the aborigines of New York and of the United States. In the heat of summer the simplest possible costume prevailed, except on festive occasions, and many had scant clothing in the winter season. On the other hand, the feather or fur dresses, or those of tanned or woven goods, have been described in picturesque terms. Without recounting these, it seems proper to give some idea how the New York Indians were arrayed when the white man came, and for some time after.

Henry Hudson said that the natives about New York bay wore various skins, and had ornaments of copper, but later writers were more elaborate in description. In the battle on Lake Champlain in 1609, the French leader was told that the three Mohawks "who bore three lofty plumes were the Chiefs, and that there were but these three and they were to be recognized by those plumes, which were considerably larger than those of their companions. . . They were provided with arrow-proof armor, woven of cotton thread and wood." Arent Van Curler mentioned similar Mohawk armor in his journal, Dec. 23, 1634. He saw a sham fight in a Mohawk town, nine men on one side and 11 on the other. "Some of them wore armor and helmets that they make themselves of thin reeds and strings so well that no arrow or axe can pass through to wound them." *Wilson*, p. 91

In the *Journal of New Netherland*, written from 1641 to 1646, it is said that the Indians "go almost naked except a lap . . . and on the shoulders a deer-skin or mantle, a fathom square of woven Turkey feathers or peltries sewed together, they make use now greatly of Duffels, Cloth Blue or Red, in consequence of the frequent visits of the Christians. In winter they make shoes of Deer Skins, manufactured after their fashion." *O'Callaghan*, 4:4

In his *Description of New Netherland* (1671) Arnoldus Montanus is quite elaborate, but had most of his account from the earlier one of Van der Donck. He said:

The clothing of the *New Netherlanders* is most sumptuous. The women ornament themselves more than the men. And although the winters are very severe, they go naked until their thirteenth year; the lower parts of the girls' bodies only are covered. All wear around the waist a girdle made of the fin of the whale or of seawant. The men wear between the legs a lap of duffels cloth, or leather, half an ell broad and nine quarters long; so that a square piece behind hangs over the buttocks and in front over the belly. The women wear a petticoat down midway the leg, very richly ornamented with seawant, so that the garment sometimes costs three hundred guilders. They also wrap the naked body in a deer's skin, the tips of which swing with thin points. A long robe fastened on the right shoulder with a knot, at the waist by a girdle, serves the men and women for an upper ornament, and by night for a bed cover. Both go, for the most part, bareheaded. The women bind their hair behind in a plait, over which they draw a square cap thickly interwoven with seawant. They decorate the ornaments for the forehead with the same stuff. Around the neck and arms they wear bracelets of seawant, and some around the waist. Shoes and stockings were made of Elk hides before the *Hollanders* settled here. Others made shoes even of straw. But since some time they prefer Dutch shoes and stockings. *O'Callaghan,* 4:125

In the *Remonstrance of New Netherland,* 1649, we are told that, beside a piece of duffels, deerskin or elk hide,

Some have a bearskin of which they make doublets; others again, coats of the skins of racoons, wild cats, wolves, dogs, fishers, squirrels, beavers and the like; and they even have made themselves some of turkey's feathers; now they make use for the most part of düffels cloth which they obtain in trade from the Christians; they make their stockings and shoes of deerskins or elk hides, some even have shoes of corn husks whereof they also make sacks. . . They twine both white and black wampum around their heads; formerly they were not wont to cover these, but now they are beginning to wear bonnets or caps which they purchase from the Christians; they wear Wampum in the ears, around the neck and around the waist, and thus in their way are mighty fine. They have also long deers-hair which is dyed red, whereof they make ringlets to encircle the head; and other fine hair of the same color, which hangs around the neck in braids, whereof they are very vain. *O'Callaghan,* 1:281

The Dutch accounts are mainly of the Algonquin tribes toward the sea. In the interior ornaments at first differed. The Iroquois had very few shell beads, but sometimes used perforated fresh-water shells and beads of colored sticks. Sweet grass was tastefully woven, and colored porcupine quills, moose and deer hair were used in embroidery. There were a few bone ornaments, and many of perforated wood. Feathers were everywhere worn, and in a tasteful way. Skins were used with or without the fur, in the latter case being finely finished and adorned.

Father Bruyas gave the names of a few Mohawk ornaments used in the latter part of the 17th century. *Asara* was a necklace or belt, used also for ornaments put around the forehead. *Garensa* was a string of glass beads. *Gentare*, to put red hair about the neck. *Ennitiagon*, to put any ornament there. *Osa* was a robe, and *Tsiosat tsonnito*, a robe made of six beaver skins. *Atouannha* was a bracelet; for these they always wore, but it is significant that no word is given for brooches. *Onnigensa* describes the hair of women hanging down behind, it being the custom to braid it. *Gannonsen*, to mark on the body with the point of a needle, is the only allusion to tattooing, though this was frequently done. *Gasire* was a covering with long hair, called Iroquois stuff. *Garisk* was a stocking, and *Garisk onwe* mittens. There are also names for shoes, socks, blankets, caps and suspenders.

Curler (Corlaer) recorded a few words of this nature in 1635. *Assire* or *Oggaha* was cloth; *Endathatste*, a looking-glass; *Tiggeretait*, combs; *Dedaiawitha*, shirts; and he obtained other names for beads, wampum, caps, stockings and shoes. They had already European articles in constant use.

While there were early notices of copper ornaments along the Atlantic coast, Hudson was the only one to mention them as occurring within the limits of New York. Native copper implements have often been found in the interior of the State, but early metallic ornaments are there very rare, comprising only small beads. After early trade or colonization commenced, all was quickly changed. Copper and brass arrows replaced those of flint, and steel knives those of stone. Brass kettles were lighter and stronger than those

of stone and clay, and soon took their place. European beads came into request, particularly the large and artistic ones of Venice, globular or elliptic. Very long glass bugle beads were also much used, and the Jesuits brought rings and medals in abundance. Metallic bangles long disputed the field with the teeth of the bear and the elk, winning the day fully only when these animals vanished from the land. With the development of the wampum trade by the Dutch, in exchange for the prized beaver furs, shell beads and larger ornaments abounded in every Iroquois village. When the red pipestone came, a little over two centuries ago, the sphere of native ornament became greatly enlarged. Till near the close of the 17th century brass and copper delighted the Indian's soul. Then came silver ornaments, holding sway for nearly two centuries more. In the last half of the 19th century these gradually gave place to the cheap jewelry of the day, and New York Indian ornaments, as such, almost ceased to exist.

In the nature of things, we have but a confused idea of how an early Indian appeared when arrayed in all his bravery. The pictures which illustrate the first histories and descriptions were made in Europe, and are the artist's conceptions of things he never saw. A few seem to have been made under the supervision of the respective writers, but even these are far from accurate. Champlain's picture of the siege of the Oneida fort is a familiar instance. The illustrations of Capt. John Smith's various accounts have the same character. In all there is a groundwork of truth, but in all the details are affected by distance and the defects of memory, and still more by the taste or imagination of the artist.

This may possibly be otherwise where verbal descriptions are given, but allowances must be made even then. Usually men described what they saw in a general way, but we must remember that many described what they had not seen, using the accounts of others. There can be no question that this was often done without the slightest intimation that the matter was not original. Bearing this in mind, a few word pictures of personal appearance may be given, some of them outside this State.

In Wood's *New England Prospect* we are told that "a Sagamore with a Humberd in his eare for a pendant, a black hawk on his *occiput* for his plume, Mowhackees for his gold chaine, a good store of Wampompeage begirting his loynes, his bow in his hand, his quiver at his back, with six naked *Indian* spatterlashes at his heels for his guard, thinkes himselfe little inferior to the great *Cham;* he will not stick to say he is all one with King *Charles.*" *Wood,* p. 74. Of the Indians in general, in 1634, he adds to this account that "although they be thus poore, yet is there in them the sparkes of naturall pride, which appeares in their longing desire after many kinds of ornaments, wearing pendants in their eares, as formes of birds, beasts and fishes carved out of bone, shels and stone, with long bracelets of their curious wampompeag and mowhackees, which they put about their necks and loynes." At that time the women wore coats of turkey feathers. He said also: "In the winter time the more aged of them weare leather drawers, in forme like Irish trouses, fastened under their girdle with buttons." For more comfort, "many of them weare skinnes about them in forme of an Irish mantle, and of these some be Beares skinnes, Mooses skinnes, and Beaver skinnes sewed together, other skinnes, and Rackoone skinnes; most of them in winter having his deepe furr'd Cat skinne, like a long large muffe, which he shifts to that arme which lieth most exposed to the winde." *Wood,* p. 73

This will suffice for the clothing and general ornaments of the New York Indians toward the ocean, who were of the same family as those of New England, and whose apparel would be much the same. A few words may be said of the Iroquois in the interior, whose early opportunities of obtaining shell and metallic ornaments were few indeed.

While most of the Huron-Iroquois went much of the time nearly naked, they did not in the least object to fine robes and ornaments for festive occasions. Champlain described the Huron women as wearing a petticoat, and often heavy strings of beads. Beaver robes were common. The Jesuits said that men and women went bare-headed, and a headdress was used only as an ornament. Their robes were the hides of elk, bear and other animals, and the women

painted these, drawing lines from the top about two inches apart. They thought most of the skin of a small black animal, as large as a rabbit and with soft fur. About 60 of these were required for a square robe. The tails hung down, making fringes, and the heads formed borders above. *Relation*, 1634

The ordinary shirt or tunic was made of two dressed deerskins, quite thin, fastened on the shoulders and reaching midway on the leg. Fringes were cut in this at the armholes and around the bottom. Coverings for the arms were sometimes added, secured about by cords before and behind. Claws, hoofs and teeth were occasional ornaments, but metallic ornaments soon replaced these. Dyed hair was freely used, and feathers and porcupine quills were often in request. In early warfare the head of some animal was often placed on the warrior's shoulder or head. Painting was customary both in peace and war, and tattooing was frequent. The former still continues among the New York Iroquois.

As this paper deals mainly with the metallic ornaments used by the Indians of New York, which are but rarely prehistoric, the foregoing will suffice to show the general attire of these nations at and about the advent of the white man. After that time changes came rapidly. Those who would follow up the subject in a broader way can not do better than to consult the *Dress and Ornaments of Certain American Indians* by Lucien Carr. This treats of the attire of the Indians of the United States east of the Mississippi, as described by early chroniclers. Of the changes of the last two centuries little is said, nor of some which came 50 years earlier. His admirable summary, with its accurate notes, is valuable and convenient for this early view, but hardly touches the subject now to be considered.

In a previous paper, some references have been made to the reports of copper articles seen by early navigators. Verazzano saw Indians wearing plates of wrought copper as he sailed along the Atlantic coast. These they valued highly. Farther northeast, the savages had copper ornaments in their ears. De Soto saw small copper hatchets in Georgia, and heard of a supply of this metal farther north. The Montreal Indians told Cartier of copper in 1535.

Gosnold met with it on the Massachusetts coast in 1602, and one of his associates has left us quite an account. Brereton said that the Indians "have also great store of copper, some very red, and some of a pale color: none of them but have chains, earrings or collars of this metal; they head some of their arrows herewith, much like our broad arrowheads, very workmanly done. Their chains are many hollow pieces connected together, each piece of the bigness of one of our reeds, a finger in length, ten or twelve of them together on a string, which they wear about their necks; their collars they wear about their bodies like bandeliers a handful broad, all hollow pieces like the other, but somewhat shorter, four hundred pieces in a collar, very fine and even set together. Besides these they have large drinking cups made like skulls, and other thin blades of copper very much like our boar spear blades." *Brereton*, ser. 3, 8:91

Another in the same company tells of "tobacco pipes steeled with copper," and of a savage who had "hanging about his neck a plate of rich copper, in length a foot, in breadth half a foot for a breast-plate, the ears of all the rest had pendants of copper."

It can hardly be doubted that this was European metal, the pale copper approaching brass or bronze, though Brereton understood from the signs of an Indian that they dug it on the mainland. The same kind of arrowhead is yet found on recent Iroquois sites. The hollow cylinders of metal had reached the Mohawk valley certainly as early as 1600. The belts with their short tubes still occur in recent Iroquois graves, "very fine and evenly set together." All these will be illustrated from various collections, and their identity can be shown by comparison with the famous relics at Fall River.

The "tobacco pipes steeled with copper" present the same difficulty that is met with in those described by Hudson in New York bay. If both descriptions are allowed, they must also have had the same origin as the arrowheads and tubes. In this connection it may be suggested, as is probably true, that Roger Williams's famous statement that the Narragansetts "have an excellent Art to cast our Pewter and Brasse into very neate and artificiall Pipes," had some slight early ground. Brass and pewter pipes occur on Indian

sites in New York, but there is little reason to think them made by the red man. Such pipes Williams probably saw among the Rhode Island Indians. They could cast pewter and lead, and he too quickly determined that all were made by them. The copper used along the Atlantic coast at the beginning of colonization is now generally conceded to be European, with some rude articles of native metal here and there. The mouth of the St Lawrence was so long haunted by European fishermen that many things may have found their way southward along the coast through aboriginal trade, but it is equally probable that some adventurer pushed his vessel along the shore, without recording his trip.

The writer's general conclusion is that native copper articles were not in use in New York as late as the year 1600, but that European articles of brass or copper were used along the seashore, and had even reached the interior by that time.

One article from the Mohawk valley, not represented here, is a stone mold for casting lead or pewter ornaments. It is a flat piece of stone in which three circles have been neatly cut, each with several deeper depressions, to form bosses on the rings. The diameter is about that of a common cent, and there are sloping grooves to carry off the superfluous metal, or to run the metal into the mold, that being covered.

Native copper ornaments

While implements of native copper have been found in New York, ornaments are very rare and mostly confined to beads. A very few are undetermined, but several forms found elsewhere are unreported here. On the other hand, no state has yielded more recent metallic ornaments, and the use of some peculiar forms yet continues. There is little that is certain as to the date of these earlier articles, but most of them may be allowed quite a respectable antiquity. The recent ones can often be dated within a score of years, being found on sites whose age and time of duration are known.

The native copper beads of New York are either small spheres or hollow cylinders, and of these the first seem most numerous.

Mr S. L. Frey gave an account of some he found in a grave near Palatine Bridge in 1879. In this grave were stone tubes. He said:

> Near the tubes, and also embedded in the hematite, I found what had apparently been a necklace or headdress, composed of copper and shell beads; the former were badly oxidized, and had been made of thin sheets of copper rolled into tubes. That they had been worn around the head or neck was evident, for one side of the skull and the lower jaw were stained a dark copper color. . . On the same level as the last grave and about 6 feet to the west of it, I came to another, similar in all respects, lined with flat stones . . . The relics found were the remains of a necklace of shell beads, little copper tubes and small seashells. *Frey*, p. 642–43

Mr Frey kindly furnished fig. 369, showing two of these beads, adding this note:

> The copper beads found in the tube graves are very small, made of rolled metal, and so much oxidized as to make it difficult to determine their original size. I, however, send the best sketch I can. They appear to have been from a quarter of an inch to 1½ inches long, and perhaps ⅛ inch in diameter.

The question of comparative antiquity is suggested by the varying character of these graves, but that most of them were of quite an early age, no one will doubt. In form the beads are precisely like those of historic times and made in the same way. Researches in Ohio have demonstrated the early use of native copper beaten into thin sheets, preparatory to use in other forms, so that this presents no difficulty.

Fig. 239 is a similar bead found by the writer by the Seneca river, in 1878, in the same field where a fine native copper spear was obtained. In section it is more nearly square than circular, and is much corroded. Small ornaments of this kind would rarely be long preserved except under favoring circumstances, and are thus naturally rare. In graves or on village sites only would they last long. This will account for the brief treatment native copper here receives.

There was a later use farther west. Alexander Henry saw native copper at the mouth of the Ontonagon river in 1765, and said that the Indians "were used to manufacture this metal into spoons and

bracelets for themselves. In the perfect state in which they found it, it required nothing but to beat it into shape." *Henry*, p. 187

Mr P. M. Van Epps described in the *American Antiquarian* for 1894 a cemetery north of Schenectady, in which a copper ax was found. In another grave afterward, 135 copper beads were obtained. In a letter to the writer describing these, he said:

The copper beads were quite peculiar, being quite unlike the common tubular beads of the western states. These were made by rolling together quite thick chunks or welts of the native copper, till the finished bead was, in some cases, as large as a small hickory nut. The bar or strip of copper used was, for some of the beads, so thick that two or three turns made a large bead. Mr Clute, the finder of the beads, told me that he gave two of the larger ones to friends, mechanics in the Schenectady Locomotive Works, who desired to pound them into finger rings, but found, to their surprise, that not a file in the works would cut them, and that they had to be annealed before they could be worked out as they wished. In short, that they were tempered or hardened. I can not vouch for this. At any rate, the beads are a unique lot, and it is very unfortunate that the finder allowed them to be separated.

These were found about 1890. The writer, himself, has seen a bit of native copper from Brewerton which rang like steel. Fig. 236 and 237 represent two of these beads still belonging to Mr Clute. Fig. 238 is a smaller one now owned by Mr Van Epps. They are very well worked, and the junction outside is not at first apparent. The surface is neatly rounded, and the ends flattened. These are some of the smaller beads. The larger ones could not be obtained.

Recent beads

The earlier brass beads show European contact preceding colonization. Fig. 245 is a fine cylindric bead of this material, well made and over 3 inches long. This came from the early fort on Garoga creek in Ephratah, and was found by Mr S. L. Frey. Fig. 256 is another from the same fort, which is less than half as long. Out of hundreds of relics found there these are all that came from the white man's hands. It is reasonable to suppose that the Mohawks who used these, had them before they left Canada. This is in the Richmond collection. Fig. 234 shows another in the same collection

from the early Cayadutta fort, south of Johnstown. This is nearly 7 inches long, straight and cylindric, and is the only European article yet reported from that site. Had these forts been near the Mohawk river, there might have been a possibility that these beads were lost by wayfarers. Their positions are too remote and difficult for this; and, as their date is just before the great influx of European articles, they may be connected with Cartier's visit to Montreal, or with traders who soon followed. [After the above was in print the writer examined a tubular bead of European copper, found on an early village site in Jefferson county in 1903. This and a fragment of pottery definitely placed this village in the latter part of the 16th century. The bead retains its smooth surface and is 1½ inches long.]

A few later examples of the same class of ornaments may be given. Fig. 243 is a fine cylindric brass bead, found by Mr Frey on the site of the early Mohawk town of *Tionontoguen*. This is 3¼ inches long. From another site he has a similar larger one, 11½ inches long and nearly half an inch in diameter. Fig. 244 is longer than the last figured, and slightly tapering, as though it might once have been the stem of a brass pipe. It is 3⅞ inches long, and was found within the stockade in Chase's woods, on the south line of Pompey. Fig. 254 is an unusually slender brass bead, found at Indian hill in Pompey. This gives it an age of nearly 250 years. It is about 2⅛ inches long and is well made. Fig. 255 is from the fort near Pompey Center, a little earlier than the last and a few miles farther south. It is ruder than most others. Fig. 257 is from the same fort, and is very neatly finished and in fine preservation. It is less than an inch long. Fig. 249 shows four small beads of polished brass, also from this site and of fine workmanship. The brass is neatly cut at the edges and symmetrically rolled. Three of them are much smaller at the ends than in the center, differing from most that the writer has seen.

While many of these beads retain their first use, no small portion were worked up from broken kettles, as other ornaments were. Fig. 248 is probably not of this character. It is a neat and cylindric coil of narrow brass or copper, forming a close but elastic tube, 3¾ inches long and over ⅜ inch in diameter. It was taken from a grave

on the edge of Canajoharie village. With it were iron tools and an R. Tippet pipe.

Fig. 246 is in the Hildburgh collection and was obtained at a recent Oneida site near the lake. It is a slender cylindric coil of thin brass, 3 inches long, and retaining the cord on which it was strung. Fig. 247 the writer picked up on a recent Cayuga site. It is slightly curved, perhaps by use, and is smaller and ruder than the last. Such forms have been abundant and were easily made.

Fig. 261 has a slight resemblance to the last, but is unique, so far as known. A slender wire was doubled and neatly twisted, making a slender link about 2¼ inches long. Several of these united in a chain made a graceful necklace. This came from the Smith farm, west of Fort Plain.

Fig. 250 to 253 are from a unique lot of slender silver beads, most of which now belong to the writer. They vary somewhat in length and thickness, some being no thicker than the common knitting needle of old times. Fig. 253 is the longest and thickest of this lot, being 2¼ inches long. They are plain or slightly ornamented. These came from the Onondaga reservation. Fig. 197 is taken from Morgan's figure of shorter but similar beads. In the latter figure the slender silver tubes were divided by globular glass beads, but this practice did not prevail among the Onondagas.

Three illustrations are given of small and spherical brass or copper beads, all of which are recent. Fig. 240 shows those which are quite small. These came from Boughton hill in Victor, and they are of the 17th century. They are now in the Buffalo collection, and are but little larger than a large pin's head. Fig. 241 shows five out of a lot of 10 beads in the Hildburgh collection. These are much larger, and came from Ontario county. They may be given the same date, as silver took the place of copper and brass about the beginning of the 18th century. Among the poorer Indians they may have continued longer. Fig. 242 shows some beads from the Onaghee site, on the McClure farm in Hopewell. They are a little smaller than the last but of the same character. These also are at Buffalo.

Fig. 235 is a unique article, differing from a cylindric bead and yet suggestive of one. It was found at Indian castle in Pompey, a site occupied in 1677 and for some time earlier. It is a long and slender silver tube, having rows of small perforations at one end. This suggests its use by the medicine men in blowing the medicinal water on the patient. It is moderately curved and is seven inches long, but is quite likely not to have been a mere ornament. If it had that character, something might have been attached by using the holes. One small elliptic lead bead came from the Onondaga fort of 1696.

Pendants or bangles

A favorite ornament for the past three centuries is a conical roll of sheet metal, attached to various parts of the dress. Collectively they may form fringes, and their tinkle adds to the music of the dance. They often have colored hair, or other adornments, drawn in so as to form tassels. The copper has often preserved these frail materials for over two centuries. They are usually of moderate size, but Mr Hildburgh has one from Oneida Valley about 5½ inches long. Mr Schoolcraft figured a cluster of three from Onondaga county, presumably from the site of 1696. He said they were "three fourths of an inch in length, bell-shaped, and composed of native copper, beat very thin." *Schoolcraft*, p. 143. At a later day his judgment would have been different. They are found on most recent Iroquois sites, but the later Indians have used other metals. The writer recalls none of native copper.

Fig. 262 is of brass and of unusual size. The writer found this on Indian hill, Pompey, many years ago, and the smaller ones were then frequent there, as well as shreds of sheet brass and copper. Fig. 263 is a characteristic example found 2 miles west of Canajoharie. Fig. 260 is one of the common form from Indian hill. Fig. 259 is one from Cayuga, retaining the ornamental hair and part of the cord. They have been common on most recent Iroquois sites, and are frequent in collections. Fig. 258 is a cluster of these belonging to an Onondaga Indian, but these are now made of iron. Lead or zinc may be used instead. One early form of bangles was of deers hoofs, and for this sheeps hoofs may be substituted.

Bells

When the French abandoned the fort at Onondaga lake in 1658, the mission bell was carried to Indian hill, and was there used for a long time. In early days nearly all the fragments of this were found, and also a small bell without a clapper. Mr Clark said that the former "would have weighed probably one hundred and fifty or two hundred pounds. The metal is very fine. . . Time and exposure have not changed it in the least. When found, some twenty years since, it was broken up, and the pieces found were enough to make it nearly entire." *Clark*, 2:276

Mr Clark also says that near the fort of 1696 "numerous little bells, such as are sometimes used by the Romish priesthood," have been found. He reported this from hearsay; but the only bells familiar to the writer from Iroquois sites are those commonly called hawk bells, like the sleigh bells of modern days, but lighter. These are frequent, and were probably attached to the dress when dancing. They are usually of brass, and are sometimes nearly perfect. Mr W. L. Hildburgh has two of silver from Ontario county, the only ones yet reported. They are as large as his brass bells, and larger than some. Fig. 267 shows one of these. They are sometimes quite small, as in two of his brass ones from the same county. Fig. 266 shows half of a large one from Pompey. Fig. 264 is a fine one from the fort near Pompey Center, and this seems the oldest yet reported. When some from that town were exhibited, a local paper said, "These bells belong to a period 3000 years ago." Fig. 265 is a smaller size from Fleming, where they are often found.

The Moravian missionary, Heckewelder, spoke of this feature of Indian dress in the 18th century. The women have "a number of little bells and brass thimbles fixed round their ankles, which when they walk, make a tinkling noise, which is heard at some distance; this is intended to draw the attention of those who pass by, that they may look at and admire them." *Heckewelder*, p. 205. At the burial of a Delaware woman of rank, on the upper borders of moccasins "were fastened a number of small round silver bells, of about the size of a musket ball." *Heckewelder*, p. 271

He elsewhere refers to the "thimbles and little brass rattles on their ankles." In the summer of 1901 the writer saw some of these thimbles in Fleming, taken from a Cayuga grave. They were simply perforated at the end for suspension, and must have admirably answered Indian purposes.

Men had plainer ornaments for a similar use, but the bells and thimbles were for the women, who were expected to be better dressed. Sometimes bits of brass were perforated and strung on the moccasins or other parts of attire, to produce a tinkling sound. These might please the ear in the dance, but it hardly seems probable they were intended to draw attention to the wearer at other times. Such ornaments were not peculiar to America.

Fig. 375 shows one of two pewter hawk bells found in Pompey, which could have produced but a dull sound. They are of small size and are now much flattened. The writer has seen no other bells of this metal.

Bracelets

Bracelets of native copper occur in various parts of the country, but there are none of which the writer feels certain in New York. These early ornaments were simple rings, usually thick, and sometimes with the ends so firmly in contact as to show they were not intended to be removed. Some of this kind were found in the great Smith mound in Kanawha county, West Virginia. They were elliptic and heavy, the ends abutting, and measured across 2¾ by 2¼ inches. There were six on each wrist of a skeleton. In the same mound was a copper quadrangular gorget with indented sides and two perforations. The length was 3½ inches by 3¾ wide. These gorgets also do not occur in New York. Some have been found in Wisconsin.

In a mound in Crawford county, Wis., was an instance of intrusive burial, with many recent relics. Among these were three copper bracelets, 10 silver ones fluted, like those in use here, a copper kettle, silver locket, silver earrings, six circular silver brooches, a copper finger ring, and a double silver cross, 5¼ by 2⅜ inches. *Thomas*. Explorations, p. 51

In the *Relation* of 1658 it is noted that the Indians not only wear bracelets on the wrist, but above the elbow and ankle, and on the leg. These uses partially appear in the account of Capt. David's dress, elsewhere given. In Romney's picture of Brant the broad and simple silver band above the elbow is conspicuous and tasteful.

A few copper bracelets in New York are much like early forms, but they also suggest nose rings. Others are made of copper wire, neatly bent into the desired form. Last come the flat silver bracelets, with holes for attachment at the ends. Many of these were made by Indian silversmiths, but the writer has seen one more elaborate pair with the name of an Albany silversmith, and one of the Wisconsin mound bracelets had on it the name of Montreal, and another the letters A. B. The silver bracelets sold at an early day by the French and English at Niagara and Oswego, are mentioned elsewhere. The Seminoles of Florida still wear silver wristlets and headbands, and make ornaments from coins.

From the site of the Onondaga fort of 1696, Mr Clark reported "bracelets for the wrists 3 inches broad, of brass highly wrought." *Clark*, 2:281. Silver was little in use then, but the writer has seen no brass bracelets anywhere which would agree with this description. They are either quite narrow or else made of copper wire, bent back and forth so as to form a broad surface. Even then they have no great width. He may possibly have referred to the long diameter, as it encircled the wrist.

Fig. 305 is a copper wire bracelet from Fleming, which is a good example of this broad form. From its size, it must have been worn by a young person or woman. Fig. 309 is of the same character and from the same place. This includes a sectional view. Fig. 307 is a narrower one from Indian hill, Pompey, which is formed like the preceding.

Fig. 308 may be either bracelet or nose ring, but it is hardly likely the Indians would have used copper for the latter. It is a single length of heavy wire, neatly rounded at the ends, and came from the last named site. Fig. 382 is of the same character and from the same place. Fig. 310 is much like this, but the ends expand. This is from an Oneida site at Munnsville. Fig. 306 is a fine example,

somewhat flattened in the center and pointed at the ends, looked at horizontally, but with uniform breadth and rounded points when viewed the other way. It is grooved within and without, describes a true circle, and came from Cattaraugus.

Two narrow brass bracelets have one edge serrated wholly or partially. Fig. 370 is one of these from Fort Bull, near Rome N. Y. The ends are shown within the figure. The serration is complete in this. The other is from Geneva N. Y., where Mr George S. Conover had several of this kind. Fig. 371 shows this. The localities place them in the middle of the 18th century.

Fig. 372 is a small, narrow bracelet of fluted silver. Fig. 373 is of the same material, but is larger and has a series of circular figures stamped on it. Both are from Geneseo and are in the Buffalo collection. They belong to the latter half of the 18th century.

Fig. 365 is a thin and broad bracelet of corrugated silver, obtained by the writer on the Onondaga reservation. It is quite elastic, and there are two holes at each end for the insertion of strings for tying it. There are several narrower examples of this form in the State Museum, which do not differ materially from this.

Loskiel observed that "both men and women are fond of silver bracelets."

The armlet was of a similar character, and therefore requires no illustration here. It was broader, and worn just above the elbow. In Romney's picture of Brant this is conspicuous and very wide. They are not in use in New York now, but were often mentioned by early writers. One white man who was taken prisoner and adopted in 1763, was arrayed in Indian costume, and had both his arms "decorated with large bands of silver above the elbow, besides several smaller ones on the wrists." *Henry*, p. 110

These armlets were still in use less than 50 years ago, but not commonly, and they have long since disappeared. The writer has seen thicker bracelets of silver, made by an Albany silversmith, but regrets that he has neither example nor drawing of these. Except in material they were much like those used by our own people.

Fig. 405 to 410 are of silver bracelets in the State Museum, all of which were collected by Mrs Converse. All are fluted, and fig.

405 has notches along one edge, and some good tracery. Fig. 410 is much like this, but the fluting and tracery are somewhat different. The former has the central lines in scallops, but in the latter they cross. Fig. 406 to 409 have no tracery, but are simply fluted. According to the writer's notes, the figures are rather deep for the size. With the depth of little more than ⅝ of an inch, they should be about 2½ inches across, but this is of no special importance. The form and style are well represented.

Brass tubes in leather belts

Brereton's account (1602) of the belts and collars, used by the New England Indians and made of hollow copper cylinders arranged side by side has already been quoted. That these were of European metal is now almost certain, though he thought them native. The arrows described are like those on recent New York sites. The copper plates, so called, are like others of brass elsewhere. The arrangement of tubes to form an ornamental belt is one familiar in western New York. The skeleton found at Fall River Mass. had similar articles, one being a brass plate 13 inches long, arrows precisely like those of the Iroquois in the 17th century, and a belt of brass tubes, each 4½ inches long, which was the width of the belt. These were not arranged on leather, as in New York, but on pieces of sinew, being much longer than our tubes.

Capt. John G. Bourke described a similar ornament of tubes, apparently not arranged as a belt:

> In an ancient grave excavated not far from Salem, Massachusetts, in 1873, were found five skeletons, one of which was supposed to be that of the chief Nanephasemet, who was killed in 1605 or 1606. He was the king of Namkeak. On the breast of this skeleton were discovered several small copper tubes . . . from 4 to 8 inches in length, and from one eighth to one fourth of an inch in diameter, made of copper rolled up, with the edges lapped. *Bourke*, p. 494

In a grave in Caldwell county, N. C., were similar articles, but they seem to have been strung as pendants for the ears. There were five copper cylinders, 1¼ to 4¼ inches long, and from a quarter to half an inch in diameter, strung on leather. They were made of thin strips of metal, rolled so that the edges met in a straight joint.

Besides this there was a bracelet of similar smaller tubes, alternating with shell beads of modern form, and four iron implements. This determines the general age of some engraved shell gorgets found in this grave, which are more elaborate than those of New York. *Thomas,* p. 337

Some copper cylinders in the Toronto collection have a general resemblance to these recent forms, and suggest a similar use, but, while the arrangement is parallel, about the diameter of the beads apart, they are differently attached. Mr Boyle said:

> This cut represents nine cylindrical copper beads just as they were found in the Tremont Park mound, Tidd's Island. They were lying on a piece of the original hide or leather to which they had been attached, and I was careful not to disturb them. They are made of beaten or leaf copper rolled into their present shape. In length they are from $\frac{3}{4}$ of an inch to an inch, and vary from $\frac{3}{16}$ to $\frac{5}{16}$ of an inch in diameter. The fine thongs by which they were sewn to the hide are still adherent to the underside. *Boyle,* 1888, p. 49

Some examples of leather belts, adorned with brass tubes, have come before the writer, and, while the number of rows may vary, the same plan was followed in all New York specimens. Parallel and vertical cuts were made in the leather, in regular lines along the belt, and each division was wound with a thin piece of brass, giving a pleasing effect. Several rows of these copper or brass tubes thus encompassed the body.

Articles of this kind would not be easily lost, or if so, easily preserved, and they can be expected only in the graves of those able to afford such ornaments. Apparently they were far from common, and but two have met the writer's eye. Fig. 276 shows one of several fragments of one of these belts, taken from a Cayuga grave near Fleming. The brass tubes in this are of considerable size, being both longer and wider than in the other example. In its fragmentary condition there is no present indication of its width, except that the broadest part of the leather may be supposed to approach one margin. To the three remaining rows of tubes not more than one could reasonably be added.

Fig. 277 is a broader fragment, which has more rows of smaller tubes. There are five of these, probably all those belonging to the

belt. The broad line of leather on the upper side may be considered the margin, and the narrow fragmentary strip on the lower edge seems to have been outside of the tube arrangement at first, as it is now. This was found by Mr C. F. Moseley, at Honeoye Falls, and thus was used toward the end of the 17th century. That century, among the Iroquois, might well be termed the age of bronze.

Small images

When the red pipestone reached New York, about the end of the 17th century, it was found available for ornaments of all kinds. Shells also were more freely used, and both aided in displacing some metallic animal figures which had been made and used to a moderate extent. Fig. 269 is one of the oldest of these, and came from Indian hill, Pompey. It represents a flying squirrel, and is made of pewter or lead. These figures have no provision for suspension, and may have been used either for a toy or charm.

Fig. 268 is a small pewter human figure which lacks the arms. It is from Indian castle, Pompey, and of about the same date as the last. It is probable such figures were at one time abundant, but, when finer ornaments appeared, these were melted for bullets. These rude forms were easily designed and cast, and may be considered purely Indian work, possibly even that of children.

This can hardly be said of fig. 272, which is a rude turtle made of iron and found on the same site as the last. The casting of iron was beyond the Indian skill, but why a white man should have made so rude a figure, it is not easy to say. Fig. 273 closely resembles this in character, but the material is lead. It came from the same site. Fig. 274 is from a site in Pompey south of the last two, and perhaps a little later in date. It is rude and broken, and seems made of copper, but this has not been determined.

Fig. 270 is a rude bird, made of lead or pewter. This came from the McClure farm in Hopewell. Fig. 271 is a small animal form of the same material, found by C. F. Moseley at Honeoye Falls.

A rude and slender quadruped of lead or pewter came from Pompey, and was evidently cut into shape. The head is broken, but the figure is yet 2¼ inches long. A well wrought horse's leg, of

the same material, is from the same place, and is now 2½ inches in length.

A very fine human figure of iron came from the same place. There is an expanded base instead of the lower limbs, and it is nude except for either a serpent or a scarf passing over one shoulder and under the other. It is but little corroded, and may be of a later date than the site. A rude but spirited figure of an ape shows greater marks of age. This is also of iron, and both may have been children's toys. The last four are now in the state collection.

Lead medals or ornaments

Of about the same age as these animal forms is a series of lead ornaments suggestive of medals. In a sense they are rude, but some have well formed letters or numerals stamped or engraved on them. Fig. 230 is an elliptic medal, the loop of which has been broken off. On the side represented is a human figure, holding by the hands to a crossbar. On one side of the figure is a serpent with open mouth. Unfortunately the writer did not draw or take notes of the reverse. It was found on Darwin McClure's farm, Hopewell. Mr J. V. H. Clark described one like this, from the Onondaga fort of 1696, as "a medal of lead, oval-shaped, an inch and a half long, with the figure of a man suspended by his outstretched hands, supposed to be a representation of our Saviour on the cross, and a figure of a serpent. On the opposite side is a figure of a man in a sitting posture, resembling the characteristic position of the native prophets; or, as some interpret it, the devil." *Clark*, 2:280

Fig. 228 is a fine lead medal belonging to C. F. Moseley, and found by him at Honeoye Falls. On the side represented were well formed letters in a circle. Within and without these are several circles, and in the center are indistinct forms. Mr Moseley thought these parts of a building, perhaps a church. The writer could trace certainly only what seemed indistinct crosses. Of the letters, BEN appeared very plainly. This may be part or an abbreviation of Benedictus. Like most of these medals, this is made of

a flat piece of lead, bent over so as to be double throughout. Compare this with fig. 374.

Fig. 229 is from Tribes Hill, in the Mohawk valley, and is in the Richmond collection. The figures are in relief, and the edge tastefully wrought. The center is irregularly perforated. Fig. 231 is from Indian hill in Pompey. It has the figures 12 above, and below 46¼ in early characters. On the reverse is a broad loop for attachment.

Fig. 232 is in the writer's possession, and was found at Boughton hill in Victor. It was formed by welding two flat pieces of lead. These have come apart, and the side having H on it forms a flat ring, the inner line of which crosses the H and forms a circle, outside of which is ornamental work. On the reverse 79 appears above a line, and other characters below. There is a long loop for suspension. Fig. 233 was furnished by Mr James Nelson, of Cold Spring N. Y. It was found on an open air workshop, on the farm of Charles De Rham, but probably had no connection with it. It is pyriform in outline, and flat. There are inscribed characters on both sides and ornamental work about the base. Mr Nelson wrote: "It seems to me it might have been made from a musket ball by one of the few Indians that lingered about the coves of the Hudson." There would seem to be too much metal in it for this origin, but an ounce ball would spread over a considerable space.

Several similar medals from Pompey were placed in the writer's hands after the foregoing were described. All either were or had been double, with projections behind for attachment. Two are nearly alike, and may be compared with the one belonging to Mr Moseley. In the best preserved of these is a castle in the center, with several turrets. Fig. 374 is of this. The other shows three small crosses on an elevation below and in front of this. This centerpiece is inclosed by two circles of points, now bent out of shape. Between these, on the left, are the letters CAM; then a crown in the center above, and on the right of this the letters PEN. Fig. 398 shows the other, with the central perforation, the back having disappeared. It has the same letters in the same position, but

the crown has been obliterated. Possibly the lettering of Mr Moseley's medal may have been the same.

Another of these Onondaga medals is rude, but is perforated for suspension. The figures 44 are in the center, with ½ on the right of these. Below is the figure 4 with some cross lines. This medal is not large. All these may have been articles thrown away by the whites after using, but picked up and treasured by the Indians.

Mr Frey has a curious and early ornament of this form and material, shown in fig. 387. It is larger than the last two, being 2½ inches in diameter, but has some features in common. In the center seems to be a shield inclosing a large fortified building, flanked by two separate towers. There is an ornamented half circle below these, and a large crown above. The date of 1630 is quite plain. The supporters are rampant animals, perhaps lions, but the heads are much worn. The one on the right shows the lion's mane. In the British arms this is the place for the unicorn. There is no lettering. Like some others, it is made of two plates, one inserted in the center of the other, and flattened to correspond with its outer surface, leaving a projection behind by which it might be attached to a belt or dress. It is much defaced, but the above features are easily seen.

Gorgets

One of the earliest metallic ornaments the Iroquois obtained was a small and perforated disk of brass, thin and saucer-shaped. It may have been used in several ways, but was probably attached to the clothing. The writer has found or seen a number of these. Mr Schoolcraft gave a figure of one of these with a characteristic description: "This article consists of a metal, which is apparently an alloy. It is slightly ovate, and is perforated in the rim, so as to have been hung transversely. Its greatest diameter is $2\frac{4}{10}$ inches. There are no traces of European art about it, unless the apparent alloy be such. Locality, valley of Genesee river." *Schoolcraft*, p. 135. Fig. 227 is from his, which is represented as being flat, but was probably slightly convex.

The finest silver gorget that has come to the writer's notice belongs to Mr Wyman, and came from an Indian grave in Mich-

igan. It is a circular disk, 6¼ inches in diameter, and with the usual tracery on the surface. Two large studs attached it to the garment. Nothing of the kind has been reported in New York, but it is likely that some of the larger ornaments for the breast had this mode of attachment. Silver gorgets were often mentioned in the 18th century, but many forms once in use are now entirely forgotten. Loskiel seems to refer to something like gorgets, where he says that the ornaments "of the men principally consist in the painting of themselves, their head and face principally, shaving and good clean garments, silver arm spangles and breastplates, and a belt or two of wampum hanging to their necks." *Loskiel*, 1:203

Fig. 221 is a small brass ornament of this kind, like a shallow saucer, and with two opposite perforations near the edge for attachment. This was found by the writer on a fort site partly in Wallace's woods, on the north line of Fabius. This was occupied early in the 17th century. Fig. 222 is a similar and larger one from another fort not far away. Both are in good condition.

Fig. 220 is a half circular piece of flat and thin brass, having a perforation near one point. Though its present form is perfect, it was probably circular at first. This came from Pompey Center. A longer one, with two perforations, came from another site in the same town.

Fig. 226 shows a small and thin brass crescent with a central perforation. It was found at Indian castle, Pompey, and suggests an ornament mentioned by Clark from an adjoining site. He said: "Several brass crescents have been found bearing the inscription, '*Roi de France et Dieu.*' These were probably used for nose and ear jewels." *Clark*, 2:262. This has no inscription, and may be smaller than those mentioned.

Fig. 275 is a rectangular brass plate from the Onondaga fort of 1696. There are two perforations near the upper corners, and the lower corners are rounded. Fig. 288 is a rude ornament of flat brass, made at the early day when every fragment of this metal was utilized. It is angular and oblong. One small hole has been completed and a larger one begun. The writer found this with fig. 221. Fig. 290 will illustrate how such fragments were used. It is

a strip of brass with three perforations. Fig. 367 is a pentagonal brass plate, and fig. 154 a brass circle, both perforated. These are from Indian hill, Pompey. There are others elsewhere.

Earrings

The earliest metallic earrings in use in New York were probably those of copper wire coiled and flattened. Fragments of these have puzzled some antiquaries. It is possible that some perforated disks and coins may have served the same purpose at an early day, but they are more likely to have been used in some other way. Glass and shell beads were also utilized for earrings, and probably many other things. In the picture of Colonel Pickering's conference at Buffalo, in 1793, all of the Indians wear in their ears large elliptic disks, each containing an engraved cross. *Stone*, 2:342. This form does not appear in any New York collections.

The earliest unmistakable form was of copper wire, bent at an acute angle in the center, and having the ends bent into a flat coil. This done, the wire was hammered down to half its first thickness. They are often broken in the center, and then give no suggestion of their use. In their symmetric form their purpose is evident. They are occasional in Canada, but are probably more frequent on Onondaga sites than elsewhere. The smallest which has met the writer's eye is a fragment from Ontario county, in the Hildburgh collection. They vary much in size.

Heckewelder described another ornament for the head which he observed at an Indian funeral. "Her long plaited hair was confined by broad bands of silver, one band joining to the other, yet not of the same size, but tapering from the head downwards, and running at the lower end to a point." *Heckewelder*, p. 270

Loskiel said: "At feasts, their hair is frequently decorated with silver rings, corals, or wampum, and even with silver buckles. Some wear a bandage round their heads, ornamented with as many silver buckles as it will hold." *Loskiel*, 1:48. He adds, "They also decorate the lappets of their ears with pearls, rings, sparkling stones, feathers, flowers, corals, or silver crosses." *Loskiel*, 1:49

One observation on Indian headdress, by this author, is of interest:

> The Delaware women never plait their hair, but fold and tie it round with a piece of cloth . . . The Iroquois, Shawanose, and Huron women wear a queue, down to their hips, tied round with a piece of cloth, and hung with red ribbands. The rich adorn their heads with a number of silver trinkets of considerable weight. This mode of finery is not so common among the Delawares as the Iroquois, who by studying dress and ornament more than any other Indian nation, are allowed to dictate the fashion to the rest. *Loskiel*, 1:52

In Miss Powell's account of an Iroquois chief in 1785, hereafter to be quoted, she said he had "a pair of immense earrings, which hung below his shoulders." The picture of Joseph Brant in his youth, by Romney, helps us to understand this, his pendants being of the same length. Half of the earring was a chain of large silver rings. From the base of this depended three chains of the same kind. A system of pendants was a favorite feature of this ornament, as will be seen later. Parts of these were easily detached and lost, and when thus separated have been misunderstood. Their Onondaga name is *Ka-wahs'-hah*.

Fig. 169 shows the earliest form of these ornaments known in New York, and was found in the Onondaga fort of 1654, where many have been obtained, both perfect and fragmentary. It is simply a piece of copper wire symmetrically coiled in opposite directions, and forming a loop in the center. This was then hammered down to a moderate degree. Of course there must have been some means of attachment to the ear, unless the opening was very large. Fig. 168 is from a neighboring site, occupied in 1677, and probably earlier. They were extensively distributed, but their use was confined to that century. They are often broken at the loop, and in this condition have perplexed some collectors.

A large proportion of the silver earrings known are later than colonial times, as will be seen in fig. 170, furnished by Mrs Converse, whose fine collection is well known. This has not only the American eagle, but the union shield on the breast. There is provision for a pendant in the loop at the base of the tail.

Fig. 171 also suggests a recent date, having the shield, scroll, eagle's head and stars. This also is imperfect, and came from Pompey. Fig. 173 is almost perfect, and was obtained at Cattaraugus by Dr Evarts. There is an arch above the spread-eagle, and a thistle head forms the pendant. These are national emblems of the United States and Scotland, but there is no reason for giving them any significance here. All that was desired was a pretty design.

Fig. 174 again shows the American eagle in an elaborate way, the stars appearing on the arch overhead. It is much like the last, having a similar boss on the breast, but the pendant is lacking. This was found long ago, at a place called the "Jumps," in the town of Clay, where the Onondagas annually met to renew the marks of the extraordinary leaps of a prisoner.

Fig. 172 is an earring of curious design, obtained by the writer on the Onondaga reservation. The elliptic center is in high relief, and has a lower notched border on each side. It is perfect, and the loop for attachment on the back is much like that of fig. 185, but more slender. This kind of loop belongs to several which follow, and is very nicely made.

Fig. 175 and 176 are much alike, differing in the number of pyriform pendants and the size of the rings. Fig. 176 seems perfect. Both belong to Onondagas, and their form seems rare. Fig. 177 is from the same reservation, and seems a triangular pendant belonging to a large earring.

Fig. 178 is unique. At the top is the half spherical ornament seen in some others, as well as the loop behind. Below this is a columellar appendage with three angular contractions varying the outline. It belongs to an Onondaga woman. Fig. 182 has the half spherical ornament just mentioned, with the usual loop. The writer obtained this pair at Onondaga, as well as fig. 185, which is of the same character but larger.

Fig. 179 is a very fine earring obtained by Mrs Converse. This form is rarely perfect. There are bosses on the lower corners of the large triangle, with a glass setting in the center. Below are three small pendants of a frequent form. Fig. 180 was obtained by the writer at Onondaga. The upper ornament frequently forms

a complete article, with or without a glass setting. It has the loop behind this diamond form, and a triangular pendant below. Both these have glass. It will be observed that there are holes for attaching three small pendants below. Fig. 181 has these pendants in place at the base of a similar large triangle, but is incomplete above. This has a glass setting, and belongs to an Onondaga woman. Fig. 184 belongs to the same person, and is elliptic in outline, with notched edges. It is imperfect. Fig. 189 is another of hers, also imperfect. It is pyriform and set with glass, and in general character is much like the upper part of fig. 183 reversed. Fig. 193 is hers also, having a common form of small pendant attached to a thick elliptic ornament by a small ring.

Fig. 183 is another of Mrs Converse's fine earrings, which seems perfect. A pyriform ornament above, with scalloped edges and glass setting, has a triangular pendant below. The top and bottom of the latter are embossed. Fig. 190 is also hers, and is unique in material, being of gold. It is a plain ellipse and of small size, increasing in thickness by successive stages.

Fig. 186 the writer got at Onondaga. It is triangular, with projections and bosses, and plainly incomplete. Fig. 191 he had from the same place. It is of a diamond form, with bosses at the angles, and is perfect. This is a frequent form, alone or in combination. Fig. 192 is similar, but plainer and with more openwork. Several of this frequent form he also obtained there, which were set with glass. Fig. 188 is the triangular base of an Onondaga earring, which has a single boss. Fig. 187 is a very pretty circular earring, set with glass, which an Onondaga woman gave to the Onondaga Historical Association.

One unique pair which the writer got at Onondaga is not figured here. The design is a small padlock, with the key attached outside. There is little probability that this was of Indian make, but most of the foregoing are of Indian manufacture. The article in question is of delicate and beautiful workmanship, but not characteristic, like those shown.

Fig. 200 is taken from one of L. H. Morgan's illustrations. It is a large silver earring, with an eagle above a large triangle. The

latter has scalloped edges, and below the base are three small pendants. Some of the Onondagas wear a plain globular eardrop attached to a ring.

In the *Annals of Binghamton* occurs the following passage regarding the triangular pendants, and what is probably the shield part of earrings, though the description is not clear. It concerned the recent Indian occupation of Windsor N. Y.:

Deacon Stow, who grew up on these plains, mentioned two kinds of trinkets which he had often found, himself. One of a triangular form, about an inch from angle to angle, made of silver, and flat, of the thickness of a 10 cent piece, with a hole near one angle; supposed to have been worn for a pendant at the nose. Another, of silver also, made of a gridiron form, and about the circumference of a half dollar. Supposed to have been worn at the nose. *Wilkinson*, p. 143

Finger rings

Father Bruyas was accustomed to give his Oneida pupils in 1670, if they could repeat on Sunday what he had taught during the week, "pour recompense une corde de rassade, ou deux petits tuyaux de verre ou deux bagues de leton." These common beads, long bugle beads, and brass rings thus became very common, and upward of 30 rings have been taken from a single grave. The glass pipes or bugle beads are still found full 4 inches in length, though usually shorter. The rings in a grave may thus testify to faithful students. On the other hand, the missionary kept partially in view religious instruction. Beads might gratify taste, but might serve a more useful purpose if made into a rosary, with a cross or appropriate medal at the end. The rings almost invariably bore sacred symbols, and may have found place elsewhere than on the fingers. No Indian need buy them if he would be studious for a week.

These early rings are mostly of a rude and cheap character, but many are of good design and finish. Quite rarely one occurs of gold or silver, or even with a setting of small stones. At a later day they were almost entirely of silver, and often of a massive form. Some of these seem to have been made by the native silversmiths. They were found on all reservations, and the art furnished an Indian surname which still survives.

Mr Crisfield Johnson mentions that in 1796 there came to Buffalo Asa Ransom, "a silversmith by trade, who . . . went to work making silver brooches, earrings, and other things in which the soul of the red man and the red man's wife so greatly delighted." This was a profitable trade. In the Richmond collection is a box of tools and patterns for making silver ornaments, obtained from an Indian. Many white persons have seen the work done. Josiah Jacobs, of the Onondaga reservation, told the writer that his uncle *Ju-ne-gant-ha* "The tribe is very large," made brooches out of silver coins on a small anvil. These were hammered out, and then cut out by patterns. Punches and chisels were used, and his greatest difficulty was in setting colored glass in pendants and earrings. Other smiths are known by name to the writer.

In his report in 1852 Mr Morgan says of this:

> The most of the silver ornaments in later years have been made by Indian silversmiths, one of whom may be found in nearly every Indian village. They are either made of brass or silver, or from silver coins pounded out, and then cut into patterns with metallic instruments. The earrings figured in the plate were made out of silver, by an Onondaga silversmith of Grand River, under the direction of the writer. *Morgan. Fabrics etc.* p. 89

In the report of 1850 he said that hatbands, arm and wrist bands, earrings and brooches of silver, were principally of Indian manufacture. For some of these bars and sheets of silver were required.

Three bronze rings were found near finger bones in a bone pit on the Tuscarora reservation, probably a Neutral ossuary. Near these was a recent Canadian penny, probably dropped there in accordance with a local custom. When the Tuscaroras disturb bones or take anything from graves, they leave a small coin as an atonement or fair exchange. *Thomas.* Explorations, p. 513

Most collections made from recent Iroquois sites have these bronze rings, and those represented are selected from the many which have met the writer's eye. One of the most remarkable is perfectly plain, and is in the Hildburgh collection. It is a simple brass or copper cylinder, about ⅞ of an inch long, and was found in Ontario county. Fig. 366 shows this fine example. Many articles which have a copper hue externally, appear yellow when cut.

The Jesuit rings are usually of brass or bronze, with an elliptic disk or seal, on which are many devices, sometimes almost effaced by use. I. H. S. with a cross above was a favorite; the heart, the letter L, the crucifixion, and sometimes a bust, appear on others. A moderate number will be illustrated. They are not often of large size, being given to young women and children as a rule. In New York none are as early as the middle of the 17th century, and few are as recent as its close. They came and went with the missions.

Cayuga county has been quite rich in these rings, and a moderate number have been figured and placed on record. Fig. 153 is one from a site near Fleming, where many have been found. There is a monogram in which M is the most conspicuous feature. A may be another part, or it may be an inverted V. As the heart above this is inverted, this may be the intention. There would thus be V. M., for Virgin Mary. Beneath the monogram is a flagon or pitcher. Fig. 343 is much like this, having the same monogram, but the fleur-de-lis takes the place of the other figures, and there is an ornamented border. It is larger than the last and came from the same place. There were five of these in one collection.

Fig. 314 has a fine full face and an illegible inscription. It came from the same place, with two others. Fig. 316 is also from Fleming, and shows a full face, with a small cross in the drapery on one side. Fig. 317 was found with the last, and has a bust with mitered head. A small cross appears. Fig. 324 is from the same place, and somewhat corroded. Though there seems to be one large cross and three small ones, it is probable that the correct rendering would be one large cross above I. H. S., as in other cases. The same may be said of fig. 329, which was found with the last, but is much smaller.

Fig. 325 is another of these Fleming rings, having I. H. S. in plain roman letters, surmounted by a cross with expanding limbs. There are three small crosses below, and an ornamental border. Fig. 330 shows another from the same place, the design of which is a large L, including a small heart and surmounted by a crown. This fine ring has an ornamental border. Fig. 334 is smaller, and has the L but not the other emblems. This is from Fleming, as well as

the next. Fig. 338 represents the crucifixion, with a bleeding heart on each side.

The following three are from the same place. Fig. 354 has a crown above and a star below. The intervening figure shows clasped hands. There were two of these, showing a neat border. Fig. 355 has the Virgin and Child, with a cross above. Fig. 347 has a heart-shaped signet, with a neat border inclosing a large A. No others have been observed like this.

Fig. 333 is from Scipioville, in the same county, and is much like fig. 330. Both have the fleur-de-lis beneath the L. Fig. 352 was picked up by the writer by a Cayuga grave, where many others had been found. At first sight there seemed to be an unfinished L, but a comparison with some to follow will show that it is the base on which the large heart was often placed.

There follow several from the McClure farm in Hopewell. Fig. 319 is a small ring with a head in profile. Fig. 320 is another fine ring, with a Maltese cross within a circle. Fig. 331 has an angular signet, with a plain border around a large L and a small heart. Few rings occur on this site.

Bronze rings have been abundant on some Oneida sites on Oneida creek, but most have disappeared. Two only will be mentioned now, both being from Munnsville. Fig. 321 has I. H. S. in plain characters, with a cross above. Fig. 358 is a small ring, with a pair of compasses inside of a ring.

Quite a number have been found at Brewerton, but of most of these neither figures nor descriptions have been secured. Fig. 315 has the unusual feature of a head with the face toward the outer edge. The work is rude for there is a great difference in these rings in every way. Fig. 359 has a very small signet for the size of the ring, and on this are circles and lines variously arranged. In 1900 there were taken from one grave in that place, 35 of these bronze rings, tied together with buckskin.

Dr Hinsdale obtained some rings in Pompey. Fig. 278 is one of these, and is a large pewter ring, with a double line of small projecting beads of the same material. Fig. 279 is a fine specimen,

with the crucifixion, and figures seated on either side. Fig. 323 is another fine ring, with an inside circle, cross and I. H. S.

The following are also from Pompey. Fig. 327 is a large and fine ring from a grave on the Williams farm, obtained in 1886. It has the cross and I. H. S., but in rather unusual form. Fig. 346 has a small head.

A number which follow are from the site of 1677, in Pompey. Fig. 313 has a king's bust and scepter. It is large. Fig. 326 is also large, and has the I. H. S. and cross. Fig. 335 has a large heart poised on a curved base, and with a border of curving lines. Fig. 336 is a smaller variant of the last, but the ring proper is more elaborate. Fig. 341 is of gold and has the Greek monogram for Christ. This is unique. Fig. 345 has a St Andrew's cross within a circle, and with dots between. Fig. 348 has characters of uncertain meaning, and the same may be said of fig. 350. Fig. 357 represents the crucifixion. This site has yielded so many rings and crosses as to suggest the thought that the Christian converts might have made it their home.

Of course Indian hill, the seat of the first Onondaga mission, would not lack articles of this kind; and a number follow from the Onondaga fort of 1654. Fig. 318 has a full face and a large key. Fig. 322 has the I. H. S. and cross while the ring part is quite elaborate. Fig. 328 is small, with I. H. S. and the cross. There is a border of dots or stars. Fig. 332 has a rather rude seal, and is small. The large L is not well done, and there may be a rude crown above it. There is a small heart and the ring part is elaborate. Fig. 340 has a small seal with a medium sized heart resting on the usual base. Fig. 342 has lines of indefinite character. Some may be intended for palms. Fig. 344 is a peculiar silver ring. The central portion is a quatrefoil, intersected by a four pointed star. In the center and at the ends of the quatrefoil are either pearls or small lustrous stones, some remaining. It is of very unusual character. Fig. 349 has characters suggestive of a Greek monogram. Fig. 351 also lacks definiteness, but was probably intended for a large heart with inclosing lines. Fig. 353 has a design suggesting either a cup or paten, perhaps with a crown above. Fig. 356 has a good figure

with extended arms, and a halo above the head. If intended for the crucifixion, the cross does not appear.

All those included in the foregoing paragraph have been recently gathered from this old town whence hundreds have been taken before. Mr Clark said that De Witt Clinton had a gold finger ring from this place, procured at the time of his visit.

Fig. 339 was sent to the writer by the late Rufus A. Grider, but the design is somewhat indistinct. A medium sized heart appears above the usual base, and there are other figures. This is from the Mohawk valley, where the old mission sites have yielded many. The writer regrets that he could not have given more attention to this class of articles, in visiting several notable collections, but time would not allow of this. Though of small size each one has minute details which must be preserved, and much time is often required to make out the design on account of corrosion. A great many, quite distinct and as full of interest, could doubtless be added to those here portrayed.

Fig. 364 is an illustration of a novel ring. A coil of iron wire several times encircled a finger, preserving the bone and as much of the flesh as came in contact. This was found in Fleming. Fig. 368 is a small coil of copper wire which may have served as a ring. This was found at Brewerton by Dr Hinsdale.

When the Iroquois made silver fashionable, bronze rings disappeared, and for two centuries their silver successors have fairly well held their place. They have disappeared more by being worn out than through a change of fashion, none having been made for many years. Fig. 363 shows one the writer bought of an old Oneida woman. The general form is well preserved, but, if there were ornamental details, they have been worn away. Mrs Converse was fortunate in getting two fine examples here illustrated from her drawings. Fig. 360 has two hands clasped over a heart. Fig. 361 has two hearts united. The symbolism is evident in both cases, though the Indians possibly may have cared little for this. Fig. 362 is the largest silver ring the writer has seen, and, as it was probably worn only on great occasions, it is in fine preservation. It was

given to Albert Cusick's mother by her second husband *Sah-go-hone-daté-hah*, "The one that spares another," a Tuscarora chief. When seen by the writer it had a string of 96 beads of mourning wampum attached to it.

Among the Onondagas *Kă-ne-kă-ah*, "Round thing," may mean a simple ring. *En-neah-hah'-sen* represents one for the finger. The former word is used for a hoop, but not for a wheel.

Fig. 383 is in Theodore Stanford's collection in Munnsville. It has an octagonal seal, containing a flaming heart beneath what may be an elongated star or a radiant cross. The ordinary rings are found on the Oneida sites about Munnsville, but most of those collected have already disappeared.

The five following rings are from Pompey, dating between 1655 and 1680. Fig. 389 has no emblems, but is of bronze. It had a setting which has been lost. Fig. 390 shows a person supporting the dead Christ. Fig. 391 may have been intended to show the letter L, but, while the work is sharp, the design is doubtful. Fig. 392 has stars, crossed arrows, etc. Fig. 393 has a circle, lines and dots. Fig. 394 is in Mr Frey's collection. There are human figures on each side of the crucified Christ.

A plain pewter ring was found at Hoffman's Ferry, which was a camping place. As these were common during the past century, the age and use are both uncertain, but, from the location, it seems to have had an Indian owner. Surface finds of this kind are subject to doubt.

Silver crosses

The finest foliated silver cross, used by Indians, which the writer has seen, was found on the banks of the Maumee river, Ohio, and was exhibited at the Pan-American Exposition in 1901. This is 13½ inches long and 8½ inches wide. It weighs 8 ounces, and is a Roman cross, each limb having foliated ends. One nearly as large, and perhaps as heavy, belongs to Mr Walter C. Wyman of Chicago. It is 12¼ inches long, and 8¾ inches wide, and is more highly ornamented than any of these large crosses which the writer has seen. Three limbs have the usual foliation, but the upper one terminates

this abruptly. At the intersection are four ornamental quadrants, forming a quatrefoil with the surface ornamentation. The base bears longitudinally the name of the former owner, *Pandikaikawa*, an Ottawa chief. Two other fine crosses are in the same collection, but they are of a different character. An account of these was given in the *Chicago Evening Post*, Oct. 8, 1898.

Two much like this, but without the central quadrants, were figured and described by Mr Charles C. Jones in the *Smithsonian Report* for 1881, p. 619. The drawings are half size, and show both faces of each cross. In these the rings for suspension remain. One cross is 8⅜ inches long by 7½ wide; the other is 8 inches long by 7¼ broad. They were taken from a grave-mould at Coosawattee Old Town, Murray co. Ga., in 1832, and are fine examples. Mr Jones said: "Indian relics were found associated with them. We incline to the opinion that they may properly be referred to the expedition of Hernando de Soto." As will be seen, their true date is the latter part of the 18th century, or possibly later. In New York and Canada they were in use but a few years ago. To show how little these were thought of as symbols, it may be said that on one of the Georgia crosses the owner had engraved an owl and a horse's head. Morgan said that birds and beasts were sometimes engraved on them, and two had the name of Montreal stamped in the center. The writer obtained all his double crosses from one pagan family.

Fig. 198 is from Morgan's report in 1852, and is a reduced figure of a cross 10 inches long and 6 wide. This he had from a Cayuga at Grand River reservation in Canada. It is of the common form. Fig. 209 is a smaller one from the *League of the Iroquois*, the size of which is conjectural, but it is apparently about 5 inches long. In the center it approaches the character of Mr Wyman's fine Ottawa cross.

Fig. 205 is a reduced drawing of a fine silver cross in the Richmond collection, which is 9¾ inches long and 7¼ wide. The ring for suspension remains. Each limb is foliated, and the name of Montreal is stamped in the center. The writer did not learn its history, but many seem to have been made at Montreal for general trade purposes, and they are usually without any religious symbols

on the surface. They may be considered mere ornaments. This also appears from Sir William Johnson's journal of Sep. 17, 1761, when he left some at Detroit for purposes of trade. They were to be sent to Mackinac. He said: "I counted out and delivered to Mr Croghan some silver works, viz, 150 earbobs, 200 brooches or breast buckles, and 90 large crosses, all of silver, to be sent to Ensign Gorrel." *Stone*. Johnson, 2:464

The smaller silver crosses are usually ornamental, and have from one to three crossbars. Those with two are most common, and have been widely distributed. A fictitious antiquity and rarity have been ascribed to these under the name of the patriarchal cross. All of the writer's examples he had of the Onondaga Indians, as stated before.

Mr David Boyle figured a fine double-barred silver cross from Beausoleil island in the Georgian bay. It is like fig. 207 but larger, being $4\frac{1}{8}$ inches high. Two others were with it. He said of this:

Double-barred crosses of this kind are now, it seems, unknown in connection with Catholic worship, and it is somewhat singular that, since we received these relics of the old Hurons, another one almost identical in size and pattern should have found its way to our collection from the Northwest, where it was picked up during the late rebellion. . . Regarding the peculiar form of cross from Beausoleil island, Dean Harris of St Catharines, writes: This small, dual cross is permitted to be worn only by patriarchs of the Latin church. It is also sometimes carried as a processional cross, and, as Richelieu was bishop and cardinal, it is possible that he used such a cross either as pectoral or processional. In all probability these ornaments were sent out to Canada during his *régime*, and, receiving the blessing of the priest among the Hurons, would have served the double purpose of being ornamental and of being used in devotion." *Boyle*, 1891, p. 64

As Richelieu died in 1642 and the Hurons were overthrown at the close of that decade, while this form of silver ornament did not come into use among the Indians till a century later, this ingenious conjecture fails; but the writer has shown that the double-barred crucifix was used in New York in the 17th century. The makers of mere ornaments since then had little care for the original use or meaning of articles, so long as they were attractive to the eye, and would sell.

Some Indian chiefs have been represented wearing the triple cross, but otherwise the only one reported and figured is Mr Wyman's. The central bar of this is longer than the others, and all the limbs are foliated. Tasteful open work adds to the effect, but the general character is that of similar double crosses. This form has been called the pontifical, but is purely ornamental in design. The figure furnished is 3¾ inches long by nearly 2¼ in the widest part. Like his others, this is from a Michigan grave.

Mr Wyman has also a fine silver double cross, 4⅞ inches long and 2½ broad, with a ring for suspension. The base is broad, and the ends of the limbs foliated, the upper crossbar being shorter than the lower. This is a common feature. Crosses of this form and size have been found in many places, and he has several. Fig. 207 is a smaller one of this form, from the Rose hill farm, east of Geneva, N. Y., and is of actual size. Though made for suspension, the broad base would allow a standing position. These are like the Canadian crosses mentioned above.

Fig. 203 shows one of several from the Onondaga reservation, belonging to the writer. They are smaller than the last, and of a slightly different form. The Indian owner had over a dozen of these, and they were common among western Indians. Fig. 201 is a cross of the same form in the collection of Mrs Converse, probably made from the same pattern, but with surface tracery. There were earlier double crucifixes of the same general form from which the merely ornamental cross may have been derived. There was a small ring for suspension, now usually lacking.

Fig. 212 is an ornamental double cross with several openings. All the limbs are foliated, and there is a ring for suspension. The general character is that of Mr Wyman's triple cross, but it is smaller. The writer had this from an Onondaga squaw, from whom a friend obtained its counterpart. The form seems rare, and both sides are ornamented.

Small silver Roman crosses seem much rarer, and none have been reported perfectly plain. Fig. 206 is of one with scalloped edges, from East Cayuga, a site occupied 150 years ago. Fig. 202 is of another which the writer bought of an Onondaga Indian in 1901.

Though nearly the same in size and design, they have not the same number of crenulations. Another was found at Portsmouth O., but they are everywhere rare.

Crosses and crucifixes of other materials

Silver articles, as a rule, were in little use by the New York Indians in the 17th century, but other materials naturally overlapped the introduction of these. Copper, brass and bronze were at first the favorites for ornament, but pewter or lead was used, and even iron had a place. Fig. 196 is a cross of lead from the McClure site in Hopewell, commonly known as *Onaghee*. Circular projections tip the three lower limbs, and it is probable that a similar one has been lost from the top, where the customary perforation would have weakened it. It is a good deal battered, but there seems to have been a human figure on its face.

Crucifixes have often been found on nearly all Iroquois sites of the last half of the 17th century. The coming of the Jesuit missionaries in 1654 marked a new era of this kind, though French and Huron captives may have brought some earlier, or they may have been among the spoils of war. Previous to that time most European articles came from the Dutch. Mr Clark noticed the finding of "a curious brass image" in Pompey, just before his history was published. He also said:

> A valuable cross of gold was several years ago found in the west part of Pompey, and was sold for $30. The significant I. H. S. was upon it. Numbers of crucifixes and crosses have been found. Brass crosses are frequently found, with those letters, and the initials of the Latin title put upon the cross at the crucifixion, I. N. R. I., and so are medals of the same metal. *Clark*, 2:273

After mentioning a brass dial plate and a paint box of the same metal, Mr Clark speaks of "another more perfect one beautifully wrought," as though meaning another box. His figure, however, is of the two sides of a crucifix, with a loop at the top and a fluted base. The obverse has Christ with extended arms, and a halo and I. N. R. I. above the head. Under the feet are the crossbones and skull. This side has a beaded border. On the reverse angels crown

the Virgin Mary, over whose head is the dove, and under her feet the skull and crossbones. *Clark*, 2:280. This is from the fort of 1696.

On adjoining lands, Mr Clark said, " brass crosses have frequently been plowed up, and some of the most perfect and highest finished ones have over the head of the Saviour the letters I. N. R. I. Most of the crosses found in other places have the letters I. H. S." *Clark*, 2:281. This was more than 50 years ago, and they are occasionally found yet, as well as on earlier sites.

A few representative early forms will be illustrated, and the reader will readily see the difference between these, with their many symbols, and the ornamental forms already described, in which these are lacking. Most of these are either of brass or lead.

Fig. 194 is the obverse of a fine brass crucifix belonging to the late Hon. George S. Conover of Geneva N. Y. He had several of these. This has a beaded border. Christ has his arms extended, a halo and I. N. R. I. are above his head, and the skull and crossbones beneath his feet. The reverse has the Virgin Mary with the moon beneath her feet, and the dove descending from above. On the arms on this side are the words IESVS MARIA. Mr Conover had this from a burial place on the Read farm, lot 32, town of Seneca. Mr Conover said: "As many as 50 crosses are known to have been found in this burial ground, and probably a great many more, as in former times, when the field was plowed, it was not an uncommon thing to find a number of crosses and other emblems with religious devices."

Fig. 217 is a fine brass crucifix from the Rose hill farm, east of Geneva N. Y., obtained by Dr W. G. Hinsdale. The obverse has Christ with the usual emblems, but with the head bent down. On the reverse are the Virgin and child, with emblems near the ends of the arms. The pointed top of this crucifix is perforated, and forms nearly a true pitch.

Fig. 214 is a brass crucifix from Cayuga county, having a beaded edge. The only emblems accompanying the figure of Christ are the halo and inscription above the head. The obverse of this is not recalled.

Fig. 195 is a brass crucifix obtained by Dr Hinsdale in Pompey. The head of Christ is bent unusually low, and the loop rises in a triangular form from the cross. Fig. 204 is a small crucifix from Pompey, the limbs ending in trefoils. Each of these includes a small circle, but the general design has become obscure through use. Fig. 211 is a beautiful brass cross with several perforations. The ends of all the arms are ornamented, and I. H. S. appears on the upper arm. Dr Hinsdale met with this in Pompey. It is an unusual form.

Fig. 213 is from a figure furnished by Dr Hinsdale of a curious bronze crucifix belonging to a boy in Pompey. It has two crossbars, and each limb is angularly expanded at the end. On the obverse the arms of Christ are extended on the upper limbs, I. N. R. I. appearing above his head. SALVATOR is on the lower crossbar, and MVNDI on the lower limb. On the reverse the Virgin occupies the center, with the sun above her head. MATER is on the lower crossbar, and DEI on the lower limb. With this was fig. 219, a fine but small brass crucifix with each arm terminating in trefoils, each of which incloses a human face. Christ and the inscription I. N. R. I. are on the obverse; the reverse has two angels crowning the Virgin Mary, and above her head is the sun.

Fig. 216 is from the Onondaga fort of 1696 and is much like fig. 213, having two crossbars and similar expansions at the ends of the arms. The design is somewhat obscure and no letters appear. Fig. 218 is from the same site. The figure of Christ is on the obverse as usual. The reverse shows the descending dove, the Virgin, and the angels on the crossbar.

Fig. 208 is a small cross from the Mohawk valley, figured by Mr S. L. Frey. The limbs terminate in trefoils, and there is some surface decoration, this being a mere ornament of comparatively recent days. It is of silver, and the loop at the top is broken. Fig. 215 is also one of Mr Frey's illustrations, but is an older article. Both sides are adorned with emblems, the obverse having I. N. R. I., the crown of thorns, nails and hammer, ladder, skull and crossbones; while the reverse has the heart in the center, the spears beneath, and other emblems on the limbs.

Fig. 210 is a brass crucifix from Munnsville, of a larger size and with more emblems, but with much the same arrangement. One end of the crossbar differs from the other.

Fig. 158 shows both sides of a thin brass crucifix found by Dr Hinsdale among the salt vats near the Ganentaha spring, the seat of the French mission house of 1656. It is of antique appearance, but in fine preservation, and the natural impulse is to connect it with this mission. The French inscription strengthens this. On comparison with recent memorials of modern religious missions, the writer is inclined to ascribe it to our own day. The obverse has Christ on an inscribed cross, and with the knees unusually drawn up. Each limb of the cross terminates in a trefoil outline, and these each include two or three small bosses on the obverse. The reverse is quite plain, and has SOUVENIR on the short, and DE MISSION on the long bar of the cross.

In the Hildburgh collection is a crucifix in which the lower limb but slightly exceeds the other three in length, these being alike in extent.

Mr Henry E. Kingman, of Owego, kindly sent an account of two brass crucifixes he found at that place in 1901, none occurring there before. One was perfect; the other broken at the base. The robed figure mentioned is the Virgin, and the general character like some before described. He said:

> On one side is the Saviour crucified, with a skull and crossbones at the bottom. Above Christ's head are the letters I. H. S., but these letters are not distinguishable on the perfect cross. On the broken one they can readily be read. On the reverse is the Saviour in his robes, while above his head is a crown, and above the crown a dove. On either side of the head is a cherub. The crucifix is 1¾ inches long from the tip of the loop to the base, and 1⅛ inch in width. The other crucifix is wider.

A fine but small brass crucifix is from Pompey, having an extreme length of 1½ inches. It is foliated in a peculiar way. There are semicircular projections on each side of the limbs, but the intermediate projection is long, narrow and pointed. On the obverse is a figure of Christ with extended arms. The reverse has the Virgin, the angels and the dove. Fig. 381 is of this.

Mr Stanford, of Munnsville, has a cross of some size, with expanding arms, suggesting the Maltese cross, but with the proportions of the Roman. Crosses and crucifixes seem rarer on the Mohawk and Oneida sites than farther west. Those of Onondaga have been most prolific, but they are now everywhere rare as compared with those found by early settlers, and are valued accordingly.

Coins

The most common coins found on Iroquois sites and used for ornaments are the liards of the 17th century. The value is about half that of the English farthing. They were at first a silver coin, but in the reign of Louis 14 became restricted to copper. On the coin the date follows the inscription, and shows several issues. In numismatic records they are described as dated in 1656 and subsequently. On Indian sites they are perforated for attachment or suspension, and are often too much worn to make sure of the date; but in New York this seems always during Louis 14's reign. Those reported as having the date of 1650 may be safely referred to 1656, a slight erosion affecting the date. In Cayuga county 44 were found in a pewter mug, which had suffered only by early use. All were of the middle of the 17th century.

The obverse has a crowned bust, with the inscription in capitals: "L. XIIII, Roy. de. Fr. et. de. Na.;" reverse, "Liard de France," across the surface. On the lower part are three fleurs-de-lis, and above these a letter, showing at what place they were made, for there were several. A stood for Paris, B for Rouen, and examples of both these are found at Indian hill, Pompey.

In Onondaga county they seem restricted to the place first visited by the French in 1654, and where the Onondagas remained till 1682. There they often occur. Fig. 303 shows both sides of one found at that place, which has two perforations. Fig. 304 is another with but one hole. Fig. 297 is from the same site, and has R instead of Roy. This has two perforations.

The writer has since had in his hands liards from Pompey of the D and E issue, the former being from the Lyons mint.

A smaller coin has a head on the obverse, face to the left, with OVR. D. C. D., with the rest indistinct. Fig. 396 is of this. On the reverse are four fleurs-de-lis, the upper one above a castle tower. Part of the inscription is AN. 1639. DOVR. One better preserved is in Theodore Stanford's collection, appearing in fig. 397. On the obverse is the King's head. LOVS remains on one side, and FR. ET. NA. on the other. The reverse now barely suggests the lilies. The date is 1640; then comes a cross, and then the letters DOVR. DE. TOV. Both these are of copper, and they are slightly wider than our present cent. No coins of older date have been reported from New York Indian sites.

Honorary medals and gorgets

Though the Indians preferred substantial presents, they were not insensible to honorable distinctions. They thought powder and ball a better means of defense than the king's arms, but tokens of personal rank they valued. So that Robert Livingston made a shrewd suggestion on returning from Onondaga in 1700, when he recommended to Governor Bellomont:

> That his Ma^{tys} armes be sent to all the 5 Nations and put up on each Castle, and if your Lord^{p} thought fit, that some of their Chief Sachems had a badge or the King's armes cut in silver to hang about their necks upon solemn days, I presume it would be acceptable. *O'Callaghan*, 4:651

Whether this was at once done does not appear, but Queen Anne did not forget the wise suggestion. At his first conference with the Five Nations, in August 1710, Governor Hunter introduced a new feature. The queen had been greatly impressed by the visit of the New York Indians to London, and took a warm interest in her forest allies, regarded by her as subjects. On this occasion Governor Hunter said:

> Her Maj^{ty} has sent them as a pledge of her protection, and as a memoriall to them of their fidelity, a medall for each Nation with her Royall effigie on one side, & the last gain'd battle on ye other, which as such she desires may be kept in your respective Castles for ever, she has also sent her Picture on silver twenty to each nation

to be given to y[e] Chief Warriors, to be worn about their necks as a token that they shall allwaies be in a readinesse to fight under her Banner against the common enemy. *O'Callaghan.* Col. Hist. 5:222

Very proud, doubtless, were these hundred warriors, but the custom begun by the English two centuries ago, and by the French still earlier, has come down to our own day.

In July 1721 the governor of Pennsylvania presented the Seneca chief *Ghesont* with a gold coronation medal of the king, charging him "to deliver this piece into the hands of the first man or greatest chief of the Five Nations, whom you call *Kannygoodk*, to be laid up and kept" as a token of friendship between them. *Hazard.* Minutes, 3:130

Possibly the plate mentioned in Penhallow's *Indian Wars* was silver medals or badges. The Six Nations and Scaghticoke Indians were well received in Boston in 1723, and the lieutenant governor "gave each of them a piece of plate, with figures engraven thereon, as a turtle, a bear, a hatchet, a wolf, etc., which are the escutcheons of their several tribes. And the more to oblige them to our interest, they had a promise made of one hundred pounds a scalp, for every Indian that they killed or took." *Penhallow,* 1:101

In the *Canadian Antiquarian and Numismatic Journal* for January 1899, Mr R. W. McLachlan gave an account of medals awarded to Canadian Indians. In this are many interesting particulars, the author being a specialist in these, and putting many early notices in an accessible form. The following observation is of general interest:

Size was of great importance to the red man, who was no admirer of miniature medals. Some were struck exceeding three inches in diameter. These were for the great chiefs, for there were smaller medals for lesser lights. . . While we may be inclined to believe that more minor than great medals were distributed, as there could not help but be more lesser than "Great Chiefs," this fact is not borne out by the number of existing medals; the larger medals are by far the more abundant. This may, in a measure, be accounted for by the fact that the minor chiefs more readily parted with their medals; and that, too, at a time when there were few collectors in the country to secure and hand them down to posterity, while the great chiefs' medals passed from father to son as an insignia of office. . . Old silversmiths relate that, as late as 60 years ago,

the Indians used to bring in their medals to have them made over into gorgets and armlets. *McLachlan*, 2:4

Mr McLachlan quotes the earliest mention of medals in Canada, in 1670-71, from volume 4 of the *Archives* of that country:

A savage of the Sault, (Caughnawaga), named Louis Atouata, godson of the King, who preserves as a precious thing the medal of which his Majesty made a present to him.

A medal was struck about 1670, for the friendly Indians of Virginia, but had no relation to New York, while most French medals came there at one time or another.

Mr McLachlan also describes a medal of 1693, in five sizes. The obverse has "the head of Louis 14, with flowing hair, and on the reverse those of his son the dauphin and the three sons of the latter." But one original is known, but restrikes have been made. This writer also quotes an account of medals used in Canada in 1723, and placed after death on the biers of Indian chiefs.

In another paper in the *Proceedings of the American Numismatical and Archaeological Society* of New York, 1883, p. 17-20, he gave two quotations not found in O'Callaghan's New York colonial documents. Governor Vaudreuil wrote thus Sep. 21, 1722:

I have received the letter with which the council has honored me, and the twelve medals bearing the portrait of the King; eight small and four large. I have continued to be careful not to be too lavish with this favor among the Indians, and to give them only to those who by their services to the nation deserve them, and to those whom I desire to bind to our interest by this mark of honor.

The reference is to an established custom. He quotes also from Beauharnois under date of Aug. 25, 1727:

Since the death of M. de Vaudreuil, the Rev. Father Jesuits have not asked medals for the chiefs of the settled Indians, for whom it was customary for them to ask some. The Rev. Father de la Chasse, to whom the Marquis de la Vaudreuil had given one, tells me it is absolutely necessary to provide some more. I have received proof of this. The Indians from above, when they come down to Montreal, would not relieve me from promising them to several who have served us well among their tribes. I pray you to enable me to satisfy these savages, and to send me a dozen small medals and six large ones.

On the same subject Governor Beauharnois wrote again, Oct. 15, 1732, to the Count de Maurepas:

I thank you, My Lord, for the twelve medals you had the goodness to send me for the Indians. His Majesty may be assured that I will make the most of them, and that I shall not distribute them except to Chiefs, whose services and attachment to the French will be known to me. As there are many such to whom I have promised such a token of honor, and as the adventure of our Iroquois and Hurons against the Foxes places me under the obligation of giving a few to the principal Chiefs of the expedition, I beg you, My Lord, to order that some be sent me next year, so that I may be enabled to invest them with this mark of honor, which also renders them more respectable among their people. *O'Callaghan.* Col. Hist. 9:1036

Sir William Johnson gave "three silver gorgets to three of the principal warriors" of the Ganuskago Indians, at Fort Johnson, Feb. 26, 1756. At the same place, July 12, he "put medals round the necks of the Shawanese and Delaware chiefs, and also to the chief Sachem of the River Indians, accompanied with the usual exhortation, also gave silver Gorgets to some of their head Warriors." *O'Callaghan.* Col. Hist. 7:160

He held a council at Onondaga lake that year. When the Onondaga speaker had concluded his address, July 2, "Sir William then rose and put a medal about the Speaker's neck and declared him a Sachem of that Council, charging him to be steady to his Majesty's interest." *O'Callaghan.* Col. Hist. 7:149

To take off the medal was to renounce friendship or allegiance, and this the French encouraged when English medals were worn. A Seneca chief, who wore an English medal in 1775, said to Governor Vaudreuil: "I tear off the medal of the King of England, which hangs from my neck and trample it under foot." *O'Callaghan.* Col. Hist. 10:378

The year before, the La Presentation Indians had sent to M. Duquesne "the medals the English had presented to some of that village who had furtively assisted at the Council at Orange." *O'Callaghan.* Col. Hist. 10:263

Two Iroquois chiefs gave up their English medals to Vaudreuil in Aug. 1756. Of another he said: "I have appointed this Onon-

daga a chief, and have decorated him with the King's medal, in consideration of the proofs he has afforded me of his fidelity," the Onondagas being then almost equally divided. In December of that discouraging year to the English, an Oneida chief gave up two English medals to the French, saying:

Father. We can not retain two medals which we have formerly had the folly to accept from our brethren, the English, as a mark of distinction. We acknowledge that these medals have been the true cause of our errors, and that they have plunged us into bad business. We strip ourselves of them; we cast them from us, in order not to think any more of the English. *O'Callaghan.* Col. Hist. 10:513

The gorgets are not usually described, but many were given to the Five Nations and Delawares. The following description, given to the French in 1758, seems that of a well known medal:

The Governor of Philadelphia has held a great council with them, at which he has distributed a great quantity of belts, calumets of peace, and more than 40 silver gorgets. A chief of the Five Nations has carried to the Commandant of Niagara one of those gorgets on which was engraved a Sun, with an Indian and a Squaw feeding a fire, and an Indian smoking a great calumet with an Englishman under the shade of the tree of peace. *O'Callaghan.* Col. Hist. 10:839

An affecting incident took place soon after Sir William Johnson's death. Some Onondagas were at Johnson Hall, Sep. 12, 1774, and the Bunt's eldest son produced the various marks of the baronet's regard.

Then (according to the old custom after such an event) he laid them down consisting of a silver hilted sword, laced hat, medals, flags, &c. before Col. Johnson, observing that his dear friend, being now no more, these things must be restored to Col. Johnson for his disposal. Then a noted Chief and particular friend of Sir Wm Johnson's arose, took off his medal &c. and did in like manner as the former, as did some others. . . Then Col. Johnson put the medals &c. about their necks and returned the several articles they had surrendered. *O'Callaghan.* Col. Hist. 8:498

A similar thing occurred at the Canandaigua conference, held by Col. Pickering in 1794. There was a condolence at the opening. Red Jacket said they returned gifts to the donors when any one died,

and he returned to the commissioners a silver gorget which had belonged to a dead chief, and which had been given him by the United States.

These were not considered equal in value to medals. In 1741 the Marquis de Beauharnois invested an Iroquois chief of the Sault with a gorget, till he could give him a medal as a mark of rank, but all medals had not this character.

The finest of the English silver medals which the writer has seen belonged to Mr John Jones, of Baldwinsville N. Y. It came to him as an heirloom, and was said to have been from the body of an Indian chief. The history is not very clear. Though it has been roughly handled by children, it is in good preservation, owing to the deep border and high relief. On one side is the British coat of arms, with the usual mottos. On the other is a fine head of George 2, facing the left. The inscription around the border is GEORGIVS. II. D: G: MAG: BRI: FRA: ET. H: REX. F:D. in roman capitals. As this monarch reigned from 1727 to 1760, the medal would come between these dates, and probably during the old French war. It is 1⅞ inches across, and is quite heavy. Fig. 280 shows the obverse of this.

In *American Colonial History illustrated by Contemporaneous Medals,* this issue is described:

Obverse: GEORGIVS II. D. G: MAG: BRI: FRA: ET: H: REX: F. D. Bust of the King, laureate, facing the left, without drapery. *Reverse.* The Royal Arms within the Garter and with supporters, helmet, crown and crest; upon the Garter, DIEU. ET. MON. DROIT. Silver, cast and chased, with loop and ring. Size 30. *Betts*, p. 177

The medal here represented accurately corresponds with this description, and must be considered one of this issue. American medalists are of the opinion that these are the 30 brought to New York by Sir Danvers Osborne in 1753, for distribution to the Indians, reference to which is made in a following paragraph. Everything agrees with the family tradition.

There is another familiar Indian medal of an earlier date, and about the size of a silver dollar, which has been found in New York. It will be observed that Indian medals not found here, or which

have no connection with New York, are not illustrated in this paper. Several colonial and Canadian medals are thus passed over.

The medal just referred to was found when the Erie canal at Oriskany was enlarged in 1849. Some graves were opened, containing 10 or 12 skeletons, with ornaments and medals. On one was a head of George 1, with the title, George, king of Great Britain, in capitals. On the reverse was an Indian behind a tree, with bow and arrow, shooting at a deer. This part of the account is clear, but some other statements are erroneous. For instance, a medal of George 1 is said to have been dated in 1731. The other medals were dated from 1731 to 1735. Some of the later Georges used the same design.

Besides one of these medals from the lower Mohawk valley, somewhat indefinitely reported, Mr Conover described one from the Read farm in Seneca, which was taken from the Indian cemetery there, and from which he deduced its age. He described it as "a copper or brass medal of about 1½ inches in diameter. On one side of this medal was the representation of an Indian with a bow and arrow in the act of shooting at a deer, a tree being between them, and the rays of the rising sun being alongside of the top of the tree. On the reverse was a medallion likeness, and around it and near the edge of the circumference the words, George, king of Great Britain. As the reign of George 1 was from 1714 to 1727, and such tokens were only presented to those Indians who were of importance among their own people," and this could not be secured in youth, he inferred that it must have been given to an old man who was buried with it in the first half of that century. As the medal might have been preserved in the family, the conclusion does not follow as to the date of the cemetery, as Mr Conover's farther statement shows:

> There has also been lately found what at first seemed a small lead bullet, which had been flattened, but, upon its being cleaned from the dirt and corrosion, it proved to be a leaden seal, such as was used in colonial times, and which had the date of 1767 cut on its face.

In the above account Mr Conover should have said the obverse had the head of the king, but this is a mere technicality. In the

series of newspaper articles by him, from which this is quoted, he recorded many things worthy of preservation. A careful and judicious writer, he did much excellent local work.

One of these figures of medals appears in Miner's *History of Wyoming* from an example found on the Susquehanna in 1814, and now said to be in a collection at Carbondale Pa. Fig. 289 is from his picture of this, but, though he said it bore the date of 1714, this does not appear. In that year George 1 began to reign. Mr McLachlan writes:

In 1859 two medals were turned up among other Indian remains, on the banks of the Ohio river. The older of these has on the obverse the head of George 1, and the other the head of George 2. The reverses of both have a representation of an Indian aiming at a deer.

More of this class of medals have been found in Pennsylvania and Virginia than elsewhere, and they are divided into these two reigns. As all may occur in New York, a brief description of some of these is given. They are of brass.

One like the medal described by Miner, but smaller and found in Virginia, is now in Wilkesbarre. Another, found at Tunkhannock Pa., has a large Indian throwing a spear at a small deer on the left. This is quite thick. Another Virginia example has on the obverse a laureated head of George 1 facing the left. The inscription is Georgius—Mag. Bri: Fra. et. Hib. Rex. in capitals. Reverse: Indian at right, nearly erect, bending forward under a tree which follows the curve of the rim, holding a bow, etc. A running deer under a tree at the left. *Betts*, p. 83

Another Pennsylvania specimen has the king's laureated bust to the left, in armor. The inscription is Georgius II. D. G: Mag. Br. Fr. et. Hib. Rex. in capitals. Reverse: Indian at right under a tree, shooting at a deer running away under a tree at the right. *Betts*, p. 84

This should probably be the left, as in the other cases, for the reported arrangement would not suit the requirements. In another medal it is possible the spear described may have come from a wearing away of the bow, changing the appearance. As no figures have been given, the descriptions are followed.

In a letter to the writer Mr McLachlan says:

Another medal for the Indians is referred to in an article in the *Historical Magazine* for September 1865, page 285, which states that "Sir Danvers Osborne, after he had been appointed Governor of New York in 1753, brought out, among other presents for the Six Nation Indians, 30 silver medals, his majesty's picture on one side, and the royal arms on the other. . . These medals seem to have disappeared, possibly a stray one may be found in some collection."

Sir Danvers Osborne died two days after his installation in office, and there is no reference to these medals in the succeeding Indian councils. The Baldwinsville medal is one of those described. A remarkably fine bronze medal found in the Onondaga valley in 1893, between the old Indian fort and the present reservation, has no reference to the Indians and yet may have belonged to one of them. It is finely executed, and was found by Mr George Slocum, in whose hands it still remains. Fig. 311 shows the obverse and fig. 312 the reverse.

On the obverse is a fine bust of the duke of Cumberland, with the legend in capitals around the edge, WILL: DUKE: CUMB: BRITISH: HERO. The other inscriptions are in capitals. Under the bust and following the rim is a scroll inclosing the words "BORN 15 APR. 1721." Next the rim, on the reverse, are the words, "REBELION JUSTLY REWARDED;" and under a group, in two straight lines, is the continuation "| AT CARLILE | ANNO 1745. |" A bareheaded officer leads forth two prisoners on the left; one of them a Scotchman with a rope around his neck; the mounted duke points with his sword to the right, as though ordering them to execution. This is not mentioned among the war medals of the British Museum.

A very interesting series of medals was designed expressly for Indian use, but the exact date is in question. An unused example is figured in the *Medaillier du Canada*, or Canadian Coin Cabinet, published at Montreal in 1888 by Joseph Leroux M. D. The brief description follows: "837. Obv.: View of the City of Montreal. MONTREAL. D. C. F. Rev.: Plain, in order to write the name of the Indian chief to whom the medal was awarded. Size 32, rarity 8."

This retains the ring in the loop above, but this is commonly lacking. On the obverse the city is represented with houses, church spires and the British flag, and has lines of defense between it and the water. A small cartouche below incloses the letters D. C. F. The reverse is perfectly smooth in this case. In others the Indian's name is in script above, following the rim. The name of the nation is in capitals, in a straight line across the center.

As Mr McLachlan has given special attention to these medals, some quotations are here made from his letters to the writer in 1891. He differs from the latter regarding the date, connecting them with Sir William Johnson's western trip in 1761. He says:

He is at Oswego, ready to sail on July 21, 1761: "Got everything on board the vessel, then met the Onondaga chiefs. When assembled, I bid them welcome. . . Then delivered the medals sent me by the General for those who went with us to Canada last year, being twenty-three in number." The taking of Montreal was almost the only engagement in which the New England Algonquin tribes acted with the Iroquois. Montreal was invested, at the conquest, by an army in which the Indians under Sir William Johnson took a prominent part, and there is no reason why the view of Montreal should have been used for any other occasion than the conquest.

In regard to other points, he adds that in his opinion an actual instead of conventional view of Montreal would have been given when better known:

The D. C. F. is a stamp such as jewelers use to stamp their plate. It has been stamped on after the medal was cast. That the name of the tribe should be spelled differently from Sir William Johnson does not matter, for the item states that they were ordered by the General, probably Amherst. He therefore would adopt his own spelling. Medals given after the Revolution bear the head of George 3 and the royal arms.

In a letter of June 4, 1902, Mr McLachlan maintains his position and adds:

I have claimed that the medal was made in New York. This is borne out by the medal described by Betts, page 227, which bears the same maker's mark. The medal is too crude in workmanship to be of English manufacture. The New York Indian medal clearly

proves that the maker was not a Canadian. Hence the medal could not have been revolutionary. As is well known in history, the bulk of the Indians that came to Montreal were from Michigan and other western districts, while those who were at the capitulation of Montreal were Mohicans and Iroquois. We find none of the Montreal medals among the tribes that were under the French influence previous to the conquest. All I have seen or heard about bear the tribal names, Mohicans, Mohawks and Onondagas. This to me is a most convincing argument. These three tribes would not have been singled out to the exclusion of the great numbers of the western tribes. Another strong proof is that we have no other medal that could have been distributed in 1761 by Sir William Johnson, as described in the entry in his diary. Then the inscription scratched on my medal must be counted of some value as evidence.

All of Mr McLachlan's arguments have been stated, and due weight should be given to them and to the rank of their author, from whom the writer is compelled to differ, though with some hesitation. I do not find it proved that these medals were made in New York and not in Montreal. Some of the best silversmiths were in the latter place at both dates mentioned. If they were made in New York, it must be remembered that that city was in British hands through nearly the whole of the revolutionary war, and was in constant communication with Quebec and Montreal. There are two medals directly relating to the conquest of Canada and the taking of Montreal, which Johnson might have used. The inscription scratched on Mr McLachlan's medal is clearly erroneous in date, as will appear later. The omission of western tribes on the medals found is no more singular than the omission of four of the Six Nations. It is negative evidence at best. Thus, while it would be unwise to say that the true date is not that of 1761, there is but a presumption in favor of that date.

Some reasons against it will appear in the descriptions of these and other medals, but others may be briefly stated here.

Conventional views of cities were then customary, as may be seen on old powderhorns and seals; Montreal was the seat of the Indian agency during the Revolution and the headquarters of warlike operations; the spelling of Onondagos is that of Col. Claus, the agent, and not that of Johnson; the River Indians were constantly employed by

the British government, had villages in the Mohawk territory, and virtually belonged to that people. In the Revolution 60 of them are said to have fought on the English side. It is improbable that Johnson had 23 medals with names and nations inscribed, for distribution at Oswego. They would have had a general character, whereas these were filled out from time to time for personal services. Some, held in reserve, were never engraved. Lastly, some of these names correspond with those of chiefs attached to early land treaties with the State of New York.

In 1761 Johnson also had similar medals for the Oneidas, but none of these have been found. He was at Oneida Old Castle, July 16, and said:

> I then acquainted them that General Amherst had sent me, some time ago, medals for such persons as went to Canada with the army last year, which I was now ready to deliver, were the persons here to whom they belonged. As they were not, must keep them till I had an opportunity of delivering them myself, that no mistake might be committed. *Stone*. Johnson, 2:432

Mr J. V. H. Clark described one several times examined by the writer:

> A silver medal was found near Eagle village, about the size of a dollar, but a little thinner, with a ring or loop at one edge, to admit a cord by which it might be suspended. On one side appears in relief, a somewhat rude representation of a fortified town, with several tall steeples rising above its buildings, and a citadel from which the British flag is flying; a river broken by an island or two, occupies the foreground, and above, along the upper edge of the medal, is the name Montreal. The initials, D. C. F., probably of the manufacturer, are stamped below. On the other side, which was originally made blank, are engraved the words CANECYA, Onondagoes. . . . There is no date on this or any other of the medals. But this must be at least older than the Revolution. *Clark*, 2:274

This should be *Caneiya* in script and Onondagos in capitals. Fig. 281 shows this medal as drawn by the writer at Mr L. W. Ledyard's, Cazenovia N. Y. in 1882. It was in his possession for many years. If of revolutionary date, as the writer thinks probable, the *Caneiya* of the medal might correspond with the Onondaga chief *Kaneyaagh*, of the treaty of 1788.

Mr McLachlan kindly furnished figures of some medals. Fig. 282 shows one of these, and his description follows:

Obverse, Montreal; in the exergue, DCF stamped in a sunk oval. A view of a walled town with a body of water in the foreground, into which a small stream flows. There are five church spires ranged along the middle of the town, and a flag displaying St George's cross to the right. Reverse. Plain; Onondagos is engraved in capitals across the field, and the name Tekahonwaghse in script at the top. Some one has, at a later time, scratched across the lower part with a sharp pointed instrument, in three lines, | Taken from an Indian | cheif in the AMERICAN | WAR, 1761.|

Mr Betts also illustrated and described this medal.

In the addition there is an evident error for there was no war in that year, but, if it were 1781, it would correspond with the *American* war, as the English termed that of the Revolution. Allowing this date, *Tekahonwaghse* might be *Takanaghkwaghsen*, an Onondaga chief who signed the treaty of 1788, or *Tagonaghquaghse*, appointed chief warrior of that nation in 1770, and perhaps the chief of 1788. Mr McLachlan had this medal from the Bushnell collection. He added, "I know of another in the collection of James Ollier of New York. I am under the impression that it is also in silver, and that it bears the name Onondagos." No account could be obtained of this.

Fig. 283 is a similar silver medal, bought by Mr McLachlan in London. On the reverse this has Mohawks in the field, and *Aruntes* above. It is in extra fine condition. This name does not appear among the many on record in the French war, nor is there any resembling it, but "The Answer of Thayendanegea a Sachem, and of Ohrante a warrior of the Mohocks to the Right Hon^{ble} Lord George Germaine", London, May 7, 1776, is preserved in full. *O'Callaghan.* Col. Hist. 8:678

Those familiar with the great variations in spelling Indian names, and the rank of this person, will have little doubt that Ohrante and Aruntes are the same. It is a curious coincidence that this well preserved medal was obtained in London, where Ohrante spent some months. In another place the Mohawk warrior is called Oteroughyanento, Indians often having two names. In the writer's exhaustive list of Iroquois personal names this nowhere else appears, but it is an unexpected gratification to link the three Iroquois names ob-

tained on these medals with well known persons of the revolutionary period.

Concerning these two Mohawks, Guy Johnson wrote in London, Jan. 26, 1776: "The Indian Chief who accompanied me, with his companion, are persons of character and influence in their country; they can more at large speak on any matters that may be required of them." *O'Callaghan.* Col. Hist. 8:657

Fig. 284 is another medal of which Mr McLachlan says:

It is in the government collection at Ottawa, and came from the collection of Mr I. F. Wood of New York. This is in pewter, and has Mohicrans in the field, either misspelled in the copy or the original. Above is *Tantalkel.* Judging from the medal given to *Tantalkel* of the Mohicans, we infer that his services could not have been valued so highly as those of the Onondaga warrior, for his reward is in the baser metal. How one of that tribe came to receive a medal is explained when we learn that 70 River Indians accompanied Johnson to Montreal.

Another Mohican fared better. The *Albany Argus*, Sep. 27, 1875, described a silver medal found by Mr Kelly of Ballston Spa N. Y. The obverse was as usual. On the reverse, as reported, was Mohicans in capitals, and *Son Gose* in script. Mr Joseph E. Wescot purchased it of the finder, and sold it in 1902 to Mr E. Hallenbeck, 749 Liberty st., Schenectady. Through the kindness of the latter, the writer is not only able to give an accurate figure, but to settle the spelling of a word in doubt. It is Mohigrans, the engraver having mistaken in his orders G for C, and R for K. It was easy to do this. The Indian's name is also *Songose.* This medal was found on the Kelly place, near the bank of the Mourning kill and the old Canadian trail. It is somewhat worn, but in good condition. It is remarkable that so many have the name of this nation. Fig. 388.

In the work of C. Wyllys Betts, already mentioned, he speaks of another Mohican silver medal, on the reverse of which was *Madoghk*, with the nation's name engraved in the usual way. He also takes note of the doubtful spelling, now cleared up by the writer's examination of the Hallenbeck medal. The error was made in all.

The Mohicans became so closely linked with the Mohawks as to share their fortunes and that of the Johnson family. Some of

them are mentioned in the raids in the Mohawk valley. The medals can hardly be referred to Burgoyne's luckless campaign, for each was engraved for a particular person, nor were the Onondagas yet in the field. None known bear the Oneida name, a significant fact, for they were on the American side. Nor were they among Butler's presents in the winter of 1777-78, who gave "in particular 300 of Burgoyne's silver medals to their young warriors." *Halsey*, p. 204. They are not all of silver.

In a description of American medals of the Revolution by J. T. Fisher of Philadelphia, *Collections of the Massachusetts Historical Society*, vol. 6 of 3d series, is one of these medals, but without place or name of Indian, and with another misspelling: "Medal—probably for distribution among the Indians. *Obverse*, A view of Montreal, and above it the name MONTREAL. *Reverse*, The name MOHIGHANS."

In *Le Medaillier du Canada* is a figure of the French Oswego medal of 1758. A better one is given by Mr Betts. As medals were very freely distributed about that time, some of these may have been placed in Indian hands, though of this there is no proof. It is nearly 1¼ inches wide. All the letters are capitals. "Avers: Bust to the right. LUDOVICUS XV. ORBIS IMPERATOR. 1758. Rev.: Four towers. Wesel, Oswego, Port Mahon, Expug, Sti Davidis arce et solo aequata." *Leroux*, p. 177

Leroux assigns a number to Indian use, but some are later than the colonial period. One has George 3 and Queen Charlotte face to face. Another may be like the fine one recently obtained from the Ottawas by Walter C. Wyman. This has a bust of George 3 to the right, and the arms of Great Britain on the reverse. There are several of this character to be mentioned later.

Mr McLachlan discredits Stone's statement that the medals of 1761, "by order of Amherst, were stamped upon one side with the baronet's coat of arms," nor does there seem any direct proof of this. He adds:

I have in my collection 10 or 12 medals relating to the Indians. One of these represents a lion watching a wolf, with a church and schoolhouse surrounded by trees in the background. This, to my

mind, relates to the conspiracy of Pontiac. French medals are now very rare; only one or two are known. After the conquest the Indians had to give them up, or exchange them for medals bearing the bust of George 3. I think it was not customary to strike medals specially for the occasion, but to give the Indians copies of some popular medal of the time; later medals bearing the arms of Great Britain, with only the name and title of the king on the obverse, for inscription. Such are all the medals of George 3, with the single exception of the lion and the wolf.

The one last mentioned has a fine bust of this monarch as a young man in armor. The inscription is simply GEORGIUS III. DEI GRATIA. There is nothing suggestive of Indian life on the medal, and Mr McLachlan merely gives it as his opinion that it referred to the Pontiac war. He states, however, that this was struck as a peace medal for a conference with the Indians at Niagara in 1764, followed by the treaty of 1765. He adds:

One of these medals, found in the grave of *Otussa* (Pontiac's son) is now in the cabinet of the United States mint at Philadelphia. A considerable number of these medals must have been struck, as two reverse dies were used. The two varieties were found in 1889 buried in one grave in Michigan. *McLachlan*, 2:14

The reverse of this large silver medal has no legend. A lion lies on the turf in the foreground, a wolf drinks at a stream, a church and house are in the background. Without an Indian symbol its Indian use seems clear. Three others of this monarch's reign are ascribed to 1762 and 1764, and two of these refer to New York. Medalists suppose them to have been struck for Canadian chiefs at the close of the French war. They are quite as likely to have been given to New York Indians, and there is no reference to Canada, as on some of earlier date.

The one ascribed to 1762 has the youthful bust of George 3 in armor, and the British arms on the reverse. One of 1764 has his bust in armor to the right, with the inscription, GEORGIUS III. D. G. M. BRI. FRA. ET. HIB. REX. F. D. On the reverse, "Happy while united," in capitals. In exergue, 1764. Indian holding a pipe, seated near an officer on a roll of tobacco. Background, city and harbor of New York. *Betts*, p. 226

Another has the same obverse, and the same date and legend on the reverse. An officer is in the foreground of the landscape, and an Indian is seated in a rustic chair on a river bank, on the right. On a rocky bank is a house, and there are three ships beyond. *Betts*, p. 227

Some medals of George 2 are of special interest. War had not prospered. Pennsylvania had suffered severely, but in 1757 a preliminary treaty was made with the Delawares and Shawnees. The Six Nations were balancing between the English and French, and great efforts were put forth for their support. So a medal was prepared in 1757, appropriate to the times. On the obverse is a laureated bust of George 2 in armor, with the inscription. GEORGIVS. II. DEI. GRATIA. On the reverse is the legend, in capitals, "Let us look to the Most High, who blessed our fathers with peace." In exergue, 1757. The field has a man seated under a tree on the right, offering a calumet to an Indian seated on the other side of a council fire. The sun is above the Indian on the left. This medal occurs in silver, copper and pewter, and is supposed to be the first struck in America. It was made for the Friendly Association for regaining and preserving peace with the Indians. *Betts*, p. 179. This is the one mentioned in the Canadian documents.

Two, relating to the conquest of Canada and the capture of Montreal, seem more likely to have been those given by Johnson to the Indians in 1761 than those which Mr McLachlan assigns to that period, as they were issued in time and relate to that event. One has a laureated head of the monarch, with the inscription, GEORGE II. KING. On the reverse is the legend, CANADA SUBDUED. In exergue, MDCCLX. S. P. A. C. A pine tree rises in the center, under which is a weeping woman seated on the ground. On the left a beaver crawls up the bank. *Betts*, p. 192

Another, issued by the same society, has points of resemblance and is of the same date. On the obverse is a river god reclining, with a bow, quiver and ax below him. A beaver climbs up the bank, and overhead is a shield with Amherst's name. The legend in capitals is, "The conquest of Canada completed." The reverse

has a mourning woman seated under a tree. To the left is an eagle, and to the right an ax, etc. The legend is, "Montreal taken MDCCLX." In exergue, "Soc. promoting arts and commerce." *Leroux*, p. 166. As these have Indian symbols, and one of them Amherst's name and that of Montreal, they seem to suit in every way Johnson's lavish distribution of medals at Oswego, when sent him by his leader.

Red Jacket's medal has been made the subject of controversy. Fig. 411 is taken from an article in *Harper's Magazine*, 1866, in which its history is given. A note says:

It is said that there are in existence other medals, each purporting to be the genuine Red Jacket medal. Possibly copies of it may have been made when it was at one time or another in pawn in the hands of those to whom Red Jacket had pledged it for whisky. But none of these copies were ever owned by Red Jacket himself. The original medal, from which our drawing was made, is, as we write, open to public inspection at the jewelry establishment of Messrs Browne and Spaulding, in Broadway, New York, by whom, with the assent of the owner, it was placed at our disposal for illustration. We have in our possession the most abundant proof that it is the genuine, and only genuine, medal presented by Washington to Red Jacket. *Harper's*, 32:324

It then belonged to General Ely S. Parker, a Seneca chief. In 1890 a medal was presented to the Red Jacket Club of Canandaigua, as having belonged to that chief. Mr William C. Bryant, of Buffalo, wrote to Hon. George S. Conover on the subject, in the following words:

Buffalo, Feb. 3, 1891

FRIEND CONOVER: There is no rational ground for doubt that the medal worn by General Parker is the one presented by President Washington to Red Jacket. This medal was a familiar object to all Buffalo residents while the old chief lived; and, after his death in 1830, it was well known that it descended to, or became the property of Jemmie Johnson, Red Jacket's nephew and the successor of Handsome Lake, the great Iroquois prophet. Soon afterward, and shortly before Johnson's death, it became the property or possession of General Parker, its present owner. In 1851 or 1852, when a boy, I visited Jemmie Johnson at his cabin, and he exhibited the medal to me.

It should be remembered that the Red Jacket medal is not a unique article, but one of many which were stricken off by the

government when Red Jacket was alive, for presentation to distinguished chiefs of the Iroquois Confederacy. There are, perhaps, two or three specimens similar in appearance to the Red Jacket medal still extant. Probably the one presented to the Red Jacket Club of Canandaigua is one of this class of medals, contemporaneous with that of Red Jacket. That it was ever worn by the old chief is not probable. Sa-go-ye-wa-tha had only one medal, and of this he was very fond and proud. During his career he owned several tomahawks and gave away at least two of them, whose subsequent history can still be traced; but he seemed to cling to this medal as if it were a most precious heirloom or sacred amulet.

I was present at the Six Nations mourning council, when General Parker was invested with the title of Door Keeper *(Don-e-ho-ga-wa)*, one of the 50 grand sachemships of the Confederacy. This was, I think, in 1850. He then wore the Red Jacket medal, and in open council it was exhibited to many of Red Jacket's compeers, none of whom doubted its authenticity.

To this Mr Conover added:

A few years since the Cayuga Indians residing in Canada employed an attorney in Buffalo to urge a claim against the State for a portion of the annuity paid by the State to the Cayugas in the United States, they having been deprived of the same since the War of 1812. Among other matters put in the hands of this attorney was a silver medal, a facsimile of which is to be found in the printed law case. This medal is of the same size, and substantially the same as the Parker medal, having the same inscription on one side, viz, "George Washington, President, 1792." This medal is claimed to have been presented to *O-ja-geht-ti*, or Fish Carrier, at that time the head chief of the Cayuga Indians, and has been in the possession of every successor in office, who has been uniformly styled by the same name from that day to the time of the present Fish Carrier. The medal presented to the Red Jacket Club at Canandaigua, I understand, is about one third smaller in size than either of the two above named.

Mr L. H. Morgan says of these:

The government has long been in the habit of presenting silver medals to the chiefs of the various Indian tribes at the formation of treaties, and on the occasion of their visits to the seat of government. These medals are held in the highest estimation. Red Jacket, Corn Planter, Farmer's Brother and several other distinguished Seneca chiefs have received medals of this description. Washington presented a medal to Red Jacket in 1792. It is an elliptic plate of silver, surrounded by a rim, as represented in the

figure, and is about 6 inches in its greatest diameter. On each side it is engraved with various devices. The medal is now worn by *Sose-há-wa*, (Johnson) a Seneca chief. Medals of seashell, inlaid with silver, were also used. *Morgan*, p. 388

At the reinterment of Red Jacket in 1884, Gen. Parker exhibited this medal. "It is of silver, oval in shape, 7 inches long by 5 inches broad. The general had dressed it in black and white wampum; the black indicating mourning and the white peace and gladness." The above long diameter includes the loop.

A copy of this medal is now in the National Museum, Washington, and data obtained thence made a difference in date and size:

The original of Red Jacket's medal is engraved. It is oval, 5¼ by 4 inches. It was presented by President George Washington, in 1795, to the Indian Red Jacket, who, with a number of chiefs of the Six Nations, visited Philadelphia, then the seat of government, at the invitation of the first president. Obverse: figure of Red Jacket presenting to General Washington the pipe of peace. In the background a man plowing and a pioneer cabin; beneath, the inscription "George Washington, President, 1795." Left field, a pine tree. Reverse: the American eagle, with clouds and rays above and 13 stars below; in beak a scroll, with "E Pluribus Unum."

Mr J. V. H. Clark described a brass medal found near Indian hill, Pompey, in 1821:

It was without date, on one side of it was a figure of Louis 14, king of France and Navarre. On the reverse side was represented a field, with three flowers-de-luce, supporting a royal crown, surrounded by the name of Nalf Lanfar & Co. It was about the size of a Spanish pistareen, had been compressed between dies, characters and letters distinct. *Clark*, 2:255

On a neighboring site a brass medal was found, on which was a horseman with drawn sword. On the other was "William, Prince of Orange", with a crest or coat of arms; the date was obliterated. William, Prince of Orange flourished in 1689, and was conspicuous in the affairs of New York for several years previous. This medal may have been a present by him to some distinguished chief. *Clark*, 2:258

That medals and coins should be sometimes found near the old colonial forts is to be expected, but they have seldom been reported, and have no necessary connection with Indian life. A fine gold

piece found near Fort Brewerton, and bearing the arms of the duke of Brunswick, has been shown the writer. From the same place came a copper medal, 1½ inches in diameter, having an erect woman, with shield and cornucopia on the obverse, and the legend, "Honor obtain'd through virtue," on the reverse. It is some years since the writer has seen this, but he has the impression that it was once a familiar form, as far as the obverse is concerned.

Religious medals

A much larger class of medals was of a religious character, usually of small size and varied forms. Mr Clark described a large one:

In July 1840 was found, on the farm of Mr William Campbell, by his son, on lot number three, La Fayette, a silver medal, about the size of a dollar, and nearly as thick. On one side is a device, surmounted by an angel on the wing, stretching forward with its left hand, looking down upon those below with a resolute, determined and commanding countenance. Far in the background is a lofty ridge of mountains. Just beneath and away in the distance, is seen an Indian village or town, towards which the angel is steadily and earnestly pointing. Above this overhangs a slight curtain of cloud or smoke. Between the village and the mountain are scattering trees, as if an opening had just been made in the forest; nearer are seen various wild animals sporting gayly. In bolder relief are seen Europeans, in the costume of priests and pilgrims, with staves, exhibiting by their gestures and countenances, hilarity, gladness and joy, winding their way up the general ascent towards the mountain, decreasing in size from the place of departure, till lost from view. Among them are wheel carriages and domestic animals, intermixed. On the right is a fair representation of a cottage, and a spacious commercial warehouse, against which are leaning sheaves of grain. The whole is surrounded by the following inscription in Dutch: GEHE AUS DEINEM VATTER LAND, 1 b. M., XII., V. 1, and at the bottom across, LASST HIER DIEGVTER. On the opposite side there is a figure of the sun shining in meridian splendor, casting its noontide rays over a civilized town, represented by churches, stores, dwellings, etc., with various domestic animals, and numerous persons engaged in husbandry and other pursuits. In bolder relief stand Europeans in the costume of the 15th and 16th centuries, engaged as if in animated and joyful conversation and greetings, and by various attitudes manifesting happiness and joy. On the right is represented a section of a church, at the door of which stands a venerable man, with head uncovered, with his hands

extended, as if welcoming these persons to a new and happy habitation. This side is surrounded by the following inscription: VND DV SOLLT EIN SEEGEN SEYN, 1 b. Mos., XII., V. 2, and across the bottom as follows: GOTT GIBT SIEWIEDER. *Clark*, 2:274

This is a great amount of detail for one medal. The quotations are from the German Bible, and relate to Abraham's migration. Clark questioned whether the medal might not be a relic of the Zeisberger mission of 1750, but the site where it was found had then been long abandoned, and it suggests the encouragement of emigration from the fatherland. It may be referred to the end of the 17th century.

Mr Clark gives figures and descriptions of several small medals, but those which follow are mostly those examined by the writer, and are but a sample of those abundant during the Jesuit missionary period.

Fig. 296 shows one which differs from the rest in having a German inscription, and its age may be uncertain. It was found on an Indian camping site near Baldwinsville in 1880, and is of brass, elliptic and thin. On one side is a border of 15 stars, inclosing a cross placed above the letter M. Below is a flaming heart, with another pierced by a sword. On the obverse is the Virgin Mary, with a halo around the head and drooping palm branches in each hand. She seems to be treading on a serpent, but this is corroded and may be a date. The German inscription follows the border in a double line. It is now indistinct and the writer made it out as follows: GEHE PA GEN . . . NDE EMPFANGEN. RITT. FUR. UNS. The inner line is D: W: ZU: D: UNSRE: ZU: FURCHT. NEHMEN. As some letters are doubtful Mr Stewart Culin suggested that the opening words might be *Gehe fagen*, and the last but one *Flucht.* The medal has disappeared, and the inscription remains in doubt. It may be recent, as the writer has examined a smaller silver one of 1830, found at Mobile in 1868, closely resembling this. It has but 12 stars, and the double inscription is in English:

"O Mary, conceived without sin,
Pray for us who have recourse to you."

This differs greatly from the German inscription above, and has been rather common in the century just past, but there are early examples which are similar. Mr Clark described a small brass medal found in Pompey, and in good preservation. It had:

The figure of a Roman pontiff, in a standing position, in his hand a crozier, surrounded with this inscription: *B. virg. sin. P. origi con.*, which we have ventured to write out *Beata virgo sine Peccato originali concepta*, or as we might say in English, The blessed Virgin conceived without original sin. On the other side was a representation of a serpent, and two nearly naked figures looking intently upon it. This one is very perfect in all its parts, and the letters as plain as if struck but yesterday. *Clark*, 2:273

He described two others from a later site. One was "an octagonal brass medal nearly an inch in diameter, having a figure with the name *St Agatha*, and the Latin word *Ora*, a part of the Gregorian chant. Also a silver medal half an inch long, with a figure inscribed *St Lucia*, and the same fragment of a chant." *Clark*, 2:280

Fig. 298 shows the first of these, and fig. 300 the second. His figure has *Ora. P. N.* in the latter instance, and these letters seem to have been obliterated in the other. This gives the familiar *Ora pro nobis*.

Many of this class of medals have been found in Cayuga county, but most of these have been dispersed. Mr Betts described one from Scipioville, on the obverse of which is a female saint, facing the right. The inscription is Santa. Rosa. de. Lima. Ord. He said that this saint is still very popular in Canada. On the reverse is a head of St Paul, facing the left, with arms crossed and holding a crucifix. *Betts*, p. 32

Though these medals are usually of brass, some are of lead and silver. Fig. 291 is of lead, and was found at Indian castle in Pompey. It is elliptic in outline, showing a bust with uplifted hand, and is perforated at the base. Fig. 294 is of silver and from the same place. It is circular and suggests a coin, but the writer recalls none like it. A lion holding arrows is on one side, and on the other three lines of letters and a date partially effaced. The date, as well as the site, is of the 17th century. There is a single perforation.

Fig. 292 is a heart-shaped medal, with an embossed heart in the center, and a dotted border. It was found at Scipioville. Fig. 293 is from the same place, and is larger than most examples. It is elliptic in outline, with a fine half length figure and a partially effaced inscription relating to Francis Xavier. Fig. 301 came from the same site and is octagonal. A fine bust, with raised hand, has an inscription around it, of which "Francis, Ora P." can yet be read. Fig. 302 is a fine example from the same place and of the same form. A cross, with a halo of rays, is above what may be either altar or font, on either side of which are kneeling figures. Fig. 295 is another octagonal medal from Cayuga county, with the bust of a man and a child. Fig. 299 shows both sides of an elliptic medal from a small site near the entrance of Onondaga creek into the lake, and which was much frequented about the year 1700. On both sides are figures apparently in ecclesiastical garments, with hoods thrown back. The inscriptions are partly effaced, but the following may be traced on one side: S. IO. . . . ANNES . . . CAPISTR. On the other appears S. P. A. S. (a chalice here in the border) CHALIS. S. . . . ON. There is a prominent loop above.

An elliptic silver medal, recently found in Pompey, is too much defaced for definite description.

Two brass medals are in Mr Stanford's collection at Munnsville. Fig. 385 is the largest of these, and has on one side a head of Christ with a halo. The inscription is IESVS FILIVS DEI. On the reverse is a head of the Virgin Mary, also with a halo, and the words MATER DEI. Fig. 384 is a smaller medal, with the Virgin and child on the obverse. On the reverse is the sun above, and below this a figure which may be altar, candlestick or font, being somewhat worn. On either side is a kneeling angel.

A fine brass medal was found by the Rev. W. H. Casey at Union Springs, in the autumn of 1902. It is in excellent preservation and is 1½ inches long, including the loop, and nearly 1⅛ wide. On one side is a fine head of Christ and SALVATOR MUNDI; on the other a head of the Virgin Mary and MATER CHRISTI. It was seen too late to illustrate here.

Brooches

About the beginning of the 18th century, Iroquois taste in ornament took a decided turn. Glass and porcelain beads were still in favor, but the brass and bronze ornaments began to give place to silver. The change came gradually, but very decidedly, and in the end affected all Indian tribes. Loskiel said: "The rich adorn their heads with a number of silver trinkets of considerable weight. This mode of finery is not so common among the Delawares as the Iroquois, who, by studying dress and ornament more than any other Indian nation, are allowed to dictate the fashion to the rest."

By the middle of that century the Indians had everywhere become critical in this matter. La Presentation (at Ogdensburg) was settled in 1749, and reference is made to silver articles in the account of the settlement in *Lettres edifiantes et curieuses.* The matter of rival trade, as between New York and Canada, was as burning a question then as now, and the latter had the same disadvantage of position in winter, enhancing the price of goods. Toronto and Niagara could have stopped, it is said, "all the savages, had the stores been furnished with goods to their liking. There was a wish to imitate the English in the trifles they sold the savages, such as silver bracelets, etc. The Indians compared & weighed them, as the storekeeper at Niagara stated, and the Choëguen (Oswego) bracelets which were found as heavy, of a purer silver and more elegant, did not cost them two beavers, whilst those at the King's posts wanted to sell them for ten beavers. Thus we were discredited, and this silver ware remained a pure loss in the King's stores. . . . To destroy the Trade the King's posts ought to have been supplied with the same goods as Choëguen and at the same price." *O'Callaghan,* p. 437

William Smith published his *History of New York* in 1756. He said of the Indians, "Many of them are fond of ornaments, and their taste is singular. I have seen rings affixed, not only to their ears, but to their noses. Bracelets of silver and brass round their wrists, are very common." *Smith,* p. 69

Heckewelder described the funeral of a woman in 1762: "Her garments, all new, were set off with rows of silver brooches, one row

joining another. Over the sleeves of her new ruffled shirt were broad silver arm spangles," etc. A good deal of wampum and many silver ornaments were placed elsewhere. A note says of the brooches, "a kind of round buckle with a tongue, which the Indians fasten to their shirts. The traders call them brooches. They are placed in rows at the distance of about the breadth of a finger one from the other." *Heckewelder*, p. 270

In Col. Proctor's journal of May 3, 1791, he relates his visit to the Onondaga village 3 miles east of Buffalo. They had 28 cabins, and were "well clothed, particularly the women, some of whom were dressed so richly, with silken stroud, etc., and ornamented with so many silver trappings, that one suit must be of the value of at least thirty pounds." *Penn. Archives*, 4:591

Miss Powell was at Buffalo in 1785, and gave an account of Capt. David, a clean, handsome and graceful Indian:

> His hair was shaved off, except a little on the top of his head, to which his ornaments were fastened; and his head and ears were painted a glowing red. Round his head was fastened a fillet of highly polished silver. From the left temple hung two straps of black velvet, covered with silver beads and brooches. On the top of his head was placed a foxtail feather, which bowed to the wind, as did two black ones, one in each ear. A pair of immense ear-rings, which hung below his shoulders, completed his headdress, which I assure was not unbecoming, though I must confess, somewhat fantastical. His dress was a shirt of colored calico,—the neck and shoulders covered so thick with silver brooches as to have the appearance of a net; and his sleeves were much like those the ladies wore when I left England, fastened about the arm with a broad bracelet of highly polished silver, engraved with the arms of England; four smaller bracelets round the wrist, of the same material; and around his waist a large scarf of very dark colored stuff, lined with scarlet, which hung to his feet; part of this scarf he generally drew over his left arm, which had a very graceful effect when he moved. And his legs were covered with blue cloth, made to fit neatly with an ornamental garter bound below the knee. *Ketchum*, 2:96

These accounts fully show the abundance of silver ornaments in that century. Elkanah Watson noticed the same thing at the treaty of Fort Stanwix in 1788. Many of the Indian women were dressed

"in the richest silks, fine scarlet clothes, bordered with gold fringe, a profusion of brooches, rings in their noses, their ears slit, and their heads decorated with feathers." These things bear out the statement made by an Onondaga to the writer, that 50 years ago some families had each a bushel of such ornaments.

In speaking of personal adornment, Loskiel said that Indian women were well dressed:

The Delaware men pay particular attention to the dress of their women, and on that account clothe themselves rather meanly. There are many who would think it scandalous to appear better clothed than their wives. *Loskiel*, 1:51

The women wore petticoats, reaching a little below the knee. Some wore garments "of printed linen or cotton of various colors, decorated at the breast with a great number of silver buckles, which are also worn by some as ornaments upon their petticoats. . . They adorn their ears, necks and breasts with corals, small crosses, little round escutcheons, and crescents, made either of silver or wampom." *Loskiel*, 1:52

Heckewelder speaks much to the same purpose:

The wealthy adorn themselves besides with ribands and gartering of various colors, beads and silver brooches. These ornaments are arranged by the women, who, as well as the men, know how to set themselves off in style. . . The women, at the expense of their husbands or lovers, line their petticoat and blue or scarlet cloth blanket or covering with choice ribands of various colors, on which they fix a number of silver brooches, or small round buckles. *Heckewelder*, p. 203

Quotations regarding the lavish use of silver ornaments, specially in the latter part of the 18th century, might be multiplied. It may be well to add what Mr Morgan has said of this feature of Seneca dress. The short overskirt of calico, called by them *Ah-de-á-da-we-sa*, and reaching above the knee, usually had one or two rows of brooches on each side, as the writer often has seen them. Morgan adds:

The Indian female delights in a profusion of silver ornaments, consisting of silver brooches of various patterns and sizes, from

those which are 6 inches in diameter, and worth as many dollars, down to that of the smallest size, valued at a sixpence. Silver earrings and finger rings of various designs, silver bracelets, hatbands and crosses, are also found in their paraphernalia. These crosses, relics of Jesuit influence, are frequently 8 inches in length, of solid silver, and very valuable, but they are looked upon by them simply in the light of ornament. *Morgan*, p. 386

The last remark should be always borne in mind. The writer has bought many of these ornaments of many Indians, but they were without significance to them. If a meaning is suggested, they will good-naturedly assent to anything; they do not think of one themselves, as Mr Morgan found.

Apparently the brooch was an evolution from the gorget, for some metallic ornaments of this kind were tied on, not buckled. Such ornaments are rare, and may never have been common. As far as known, they are circular, and like the brooch of that form except in the center. Fig. 17 is a silver one of this kind, having four interlacing rings inside of the outer circle. There is no place for or sign of a buckle, and it was probably tied or sewed to the garment, for there is no reason to think it was suspended. This was found in the town of DeWitt N. Y. and is in the Richmond collection. Fig. 21 is a smaller one of the same design from the Mohawk valley, which belongs to Mr Frey. A large and handsome one from Ohio was shown at the Pan-American Exposition. In this a slender outer ring inclosed an open six pointed star, bisected by an inner circle. Fig. 160 is of copper and has no central opening. It is from the site of 1677 in Pompey, and is unfortunately broken.

Like wampum, the silver brooches partially answered the purpose of money. The Onondagas often placed them in pawn, but sometimes parted with them at a fixed value. Some visitors at Oquaga, in 1769, observed this there. "Some of the women wear silver brooches, each of which passes for a shilling, and are as current among the Indians as money. Brant's wife had several tier of them in her dress, to the amount perhaps of 10 or 15 pounds." *Halsey*, p. 143. That is, she wore from 200 to 300 of these; and this seems no rare example.

The brooch proper has a central opening, across which a tongue extends, like that of a buckle. The cloth is pinched up and passed through this opening, the tongue penetrating it twice, when it is drawn back, and the brooch is firmly in place. When they were plentiful, the smaller ones were usually arranged in two lines down the center of the overskirt in front, and across the front of the lower edge. The larger ones were reserved for the upper part of the dress. Sometimes small ones were arranged on ribbons. Most of the smaller forms were very abundant. In those of similar outline quite a variety was obtained by varying the perforations and the surface ornamentation. The latter was mostly made with punches, but the graver was occasionally used. Those formed of brass are extremely rare, the writer having obtained but two among the hundreds of silver ones which he has seen. There are early examples in graves. Of these the writer has seen several from graves in Wisconsin. They were mostly circular, but one stellar brooch had broad and short rays.

Preliminary to further descriptions it may be said that Mrs Harriet Maxwell Converse furnished an illustrated paper on "The Iroquois Silver Brooches" for the State Museum report for 1900. Many of the illustrations will be recognized here, nearly half coming from the writer's collection and the remainder, also found in the paper mentioned, from that of Mrs Converse, there being a mutual interchange of figures.

Fig. 31 is a fine brass brooch which the writer obtained at Onondaga. It is a circular ornament of good size, with crenulated and embossed edge. To show the rarity of this material employed in such a use, it may be said that an Indian friend was surprised at it, never having seen one of the kind before. The writer afterward secured another circular brooch of brass which was plain and much smaller.

The simplest and perhaps earliest form of the brooch seems to have been that called the round buckle, allusions to which have been quoted from several authors. It is frequent yet, either plain or ornamented. With the three double-barred silver crosses, described by Mr Boyle in Canada, was a piece of cloth decorated with 20 of these. Dr Evarts, of Silver Creek N. Y., showed the writer

35 plain rings buckled on a piece of cloth, which he had from the neighboring Cattaraugus (Seneca) Indians. The writer has many of various styles of finish, and might easily have had more. In the 18th century they were cheap as compared with others, and were lavishly employed. A few are shown.

Fig. 35 is one out of a number the writer obtained at Onondaga. Fig. 38 is out of another lot he had from the same place. These are rounded on the face and flat on the back. It is quite a common size. Fig. 23 is a larger size from the same place, and made in the same way. Fig. 25 differs from these in being broader and flat. The writer had this also from Onondaga, but it is not so common as the last. Many of these simple forms have some surface ornamentation. Fig. 19 was found in the Mohawk valley, and is small, elliptic, and has many transverse grooves. Fig. 24 has the same style of ornament, but is larger and circular. It is also a Mohawk example.

Fig. 85 preserves the circular form, but has broad undulations on the surface. This and the next three the writer had from Onondaga. Fig. 88 differs from the last in having the indentations only on the outer edge of the surface, and in their being separate instead of continuous. Fig. 90 is a flat ring, with distinct indentations on each edge of the surface. It is a fine and rather rare form. Fig. 91 is worked so as to show a continuous series of semicircles all around the center of the surface. This is not a frequent style now. Fig. 74 has nine bosses on the surface, with intervening cross lines. The writer got this at Onondaga, and has seen none like it.

Fig. 46 was given to the Buffalo Historical Society by Mrs Van Rensselaer, with other fine brooches. It has the ring form, but of an angular style. At each angle is a boss, the intervening space being narrower and with three cross grooves. Fig. 73 has a similar character, but the curved spaces between the bosses have no grooves. This came from the Tuscarora reservation.

Fig. 20 is the smallest of the circular brooches, which the writer has seen, that can not be classed with the ring brooches or round buckles. Small as it is, eight small circles adorn the surface. It is almost flat, and came from a grave in Cayuga county.

No brooches are more effective than those having the form of a star, and the writer has been fortunate in securing many figures and examples of these. They are usually flat, but fig. 1 has a slightly convex surface. This is of a large size, and has a heart-shaped opening in the center, and 20 short embossed rays. They never have sharp points, as these would be inconvenient. This came from the Cattaraugus reservation. It is more highly ornamented than most of these. Fig. 2 shows a fine star brooch, with eight rays and an ornamented surface. This the writer had from Onondaga.

Fig. 3 is another Cattaraugus star brooch, with 16 short embossed rays. It is otherwise perfectly plain. Fig. 5 is another from Cattaraugus, with eight rays. The writer obtained three of these, and they are the smallest of the kind he has seen. They were probably used on ribbons. For its size this is well ornamented.

Fig. 4 is a fine, large star from Onondaga, with 12 embossed rays. In the figure dark spaces show all the perforations except the central one. Fig. 6 is a small star brooch from the Tuscarora reservation, with seven rays. The surface decoration is simple.

The following five the writer obtained at Onondaga. Fig. 7 is a star of 13 rays with a well ornamented surface. Fig. 8 has 12 rays, and is much smaller and simpler. Fig. 9 is one of the prettiest he has found. The edges of each of the nine embossed rays are slightly concave, and the surface ornaments are made to correspond. Fig. 10 is the largest he has obtained or seen. It is quite thick, has 12 embossed rays, and the surface is neatly adorned. The full width is over 3¼ inches. This fine ornament belonged to Chief Abram La Fort, or *Te-hat-kah-tous,* who died in 1848. Fig. 15 has 12 embossed rays and neat surface decorations. Fig. 49 is also from Onondaga, and has 12 short rays. This belonged to Miss Remington, once employed in mission work there.

Fig. 11 is a small star in the writer's collection, sent him by Dr C. B. Tweedale, and which was found in a grave in Huron county, Ont., Canada. It has a plain surface and eight embossed rays. The writer has many drawings of Canadian brooches, some

very fine, but they do not differ essentially from those of New York, where many of them were probably made.

Fig. 12 is a small and plain star of 12 rays, which the writer had from the Allegany reservation. Fig. 16 is a fine star from the same reservation. It has 14 quite short embossed rays. Fig. 13 is a fine star with eight broad rays and bosses, belonging to the Buffalo Historical Society. Fig. 14 is in the Richmond collection and is quite peculiar. The central perforation is quite large, and the 12 long rays terminate in circular points, which are not embossed. The surface decoration is simple. This is one of a number of Seneca brooches in this collection.

Mrs Harriet Maxwell Converse secured a large and interesting collection of brooches, part of which now belongs to the State. The writer is indebted to her for figures of many of these, a number of which will be used in this paper. Fig. 22 is a large circular brooch, with a plain rim and an included star with embossed points. Both the dark and light spaces in the figure show perforations. The star has 12 rays. This fine brooch is of a rare type. The three following are also Mrs Converse's. Fig. 32 is large and circular. The 16 projecting bosses have incurved edges between them, and the slightly convex surface is finely ornamented with perforations and tracery. The circular brooches have raised centers as a rule. Fig. 48 is a very pretty and peculiar brooch. Included in the edge are 16 very small bosses, with convex edges between them. The perforations are of an unusual form, and the tracery of a rare character. Fig. 61 has a broadly undulated edge, and the border decoration is not of a common type. Mrs Converse died Nov. 18, 1903.

Fig. 18 the writer obtained at Onondaga. It has 24 projecting bosses on the plain circular edge. There are circular, semicircular and elliptic perforations and some tracery. About two dozen follow which the writer had from the same place. All which succeed are circular till otherwise distinguished.

Fig. 27 has a crenulated edge and three rows of nearly semicircular perforations. Fig. 29 has a similar border, and semicircular, elliptic and triangular openings. Fig. 33 has the same edge, two rows of semicircular and one of elliptic perforations. Fig. 34 is

large and fine, with a broadly crenulated border. Besides the large central one, the perforations are semicircles, rectangles, hearts and triangles. Fig. 34*a* is of good size, with a crenulated border, and three rows of semicircular openings. Fig. 39 is a handsome brooch, with 16 small bosses at the intersection of the crenulations in the border. There are three lines of semicircular openings, and another of quadrilateral forms. Fig. 41 has small bosses closely set around the rim, and is of small size. All the perforations are angular, and nearly or quite quadrilateral. Fig. 42 is much like the last but in every way smaller. The central aperture corresponds with that, but the four openings outside of this are semicircular.

Fig. 43 has the frequent crenulated edge, a line of semicircular, and another of elliptic openings, but between each of the last is a small boss, amounting to six in all. They are rarely found in this position. Fig. 50 is a very pretty but small brooch, with crenulated border. The perforations are elliptic and point to the center. Fig. 53 is small, and has small bosses closely set around the edge. The perforations are elliptic and triangular, and the tracery of unusual design. Fig. 54 is large, with broad crenulations. The openings are two lines of semicircles and one of long triangles. Fig. 58 has a plain edge, with bosses projecting all around it. The apertures form a single line of semicircles. It is a simple but very handsome ornament.

Fig. 59 is a very simple style, with crenulated edge and one row of semicircular apertures. Fig. 60 has the same edge, with a line of semicircular openings and another of hearts and circles. Fig. 63 is a small but showy brooch. Medium sized bosses intersect the angles of the crenulated edge. The apertures are semicircles, ellipses and triangles. Fig. 64 has a crenulated edge, a line of crescents, and another of ellipses. Fig. 65 differs from the last in tracery, and in having an inner circle of stars. Fig. 67 has a crenulated border, and for apertures semicircles, ellipses and triangles. Fig. 68 has broader crenulations than most, and two lines of semicircular apertures.

Fig. 69 is very simple but effective. The crenulations are of moderate width, but halfway to the central aperture is a line of

eight large circular openings. Fig. 77 is one of the plainest kind. The edge is simple, and a star appears in tracery on the otherwise plain surface. Fig. 79 is a pretty brooch with broadly undulated edge. There are eight pyriform apertures, but the graceful tracery gives a pleasant effect. Fig. 89 is of unusual character. Small bosses appear at intervals around the otherwise plain edge, and there is a circle of apertures of the indented shield form. The surface decorations are small circles and dots.

After the above was in print the writer obtained a fine circular brooch 4¼ inches across, but not as heavy as the La Fort star. It has 23 obtuse points, two rows of diamond perforations, a row of shield form apertures, and delicate tracery. It came from the Senecas. Some others have been noted but not figured here.

Besides his own circular brooches from Onondaga, selected above, the writer has figured many in the hands of Indians there, or in those of friends who have since parted with them. Some of these will follow, simply credited to Onondaga. Fig. 26 is a fine example of these. It has large bosses on the edge, with double crenulations between them; inside of the border is a line of cordate and triangular apertures, with openings between these and the heart-shaped opening in the center. Fig. 28 is another large brooch with crenulated edges and many perforations. A double row of these, of triangular form, gives the effect of a central star. Fig. 30 is about half the diameter of the last, and has the common crenulated edge. The apertures are lines of crescents, circles and triangles.

Fig. 36 is quite small, and has a crenulated edge. The only decoration is a line of small circles on the surface. Fig. 40 has broad crenulations. The apertures are semicircular and quadrilateral. Fig. 45 has also broad crenulations. One line of ellipses is parallel with the edge; the others point to the center. This has less tracery than the last. Fig. 57 is a rare form. Every third crenulation slightly projects, giving the border an angular appearance, and there are six circular apertures besides the central one. The tracery is tasteful. Fig. 76 has a crenulated border and a line of elliptic apertures.

Fig. 80 is small, but of an unusual design. The border is crenulated, and within are alternate crescent and cordate apertures, four of each, the latter pointing to the edge.

The following, in the writer's collection, come from the Allegany reservation. They are circular, but others from that place are of other forms. Fig. 52 has the broad crenulations finely serrated, a rare feature. There are lines of semicircular, pyriform and very small circular apertures. Fig. 70 has a crenulated border, and two lines of semicircular openings within.

Some other Allegany circular brooches follow. Fig. 51 is a small brooch with crenulated edges. The apertures are crescent and pyriform. Fig. 66 is a very pretty example. The crenulations are alternately long and short, and the perforations are semicircular and triangular. The central aperture is angular, and the tracery adds much to the beauty of this ornament. Fig. 71 is unique. There are eight short projecting points united by curved edges, and two lines of diamond form apertures. Fig. 75 has a plain rim and eight triangular openings. The effect is that of an included star. Fig. 81 has a broadly undulating edge, and a line of elliptic openings pointing to the center. Fig. 84 has a finely crenulated border and a circle of small bosses within this. All the openings, including the central one, are quadrilateral. This is a rare feature in a circular brooch.

The following are in the Buffalo collection. Fig. 37 has broadly crenulated edges, with an inner line of semicircular openings. Within this is another line of six elliptic apertures, alternating with those which may be called cuneiform. The tracery is of small circles and arrow points. Fig. 44 has a crenulated border and a line of triangular openings. An inner line of crescents and delicate tracery adds much to the effect. Fig. 47 has a crenulated edge, and lines of crescent and elliptic openings. Fig. 58*a* is crenulated, and the apertures are cordate and elliptic. It is a very pretty brooch.

The writer secured a number on the Tonawanda reservation, but there was but little variety among them. Fig. 62 is one of these. It has a plain rim, but the single line of semicircular openings gives a starlike appearance to the center. Fig. 82 has very promi-

nent crenulations, and lines of crescent, elliptic and triangular openings. There are many like this.

Three Seneca circular brooches are shown from the Richmond collection. Fig. 56 has a close line of small bosses along the border, and there are four long quadrilateral openings toward the central one, which is both large and angular. Fig. 72 has a similar line of bosses. The apertures are elliptic and triangular. Fig. 78 has a simple rim, and the only aperture is the central one. On the surface are triangles and other tracery.

Fig. 199 is taken from a figure by L. H. Morgan, showing a circular brooch of what is now a very extreme size. The apertures are a line of ellipses, one of large and one of small triangles.

Fig. 55 was not mentioned among Mrs Converse's circular brooches. The border is broadly crenulated, and 13 cordate apertures point to the center. Surface tracery unites some of the hearts so as to form a six pointed star. Her collection comprises some of the rarest forms now to be obtained, and these will successively follow, except the Masonic forms. The localities are unimportant and will be omitted.

Fig. 92 is grotesque and involved. There are animal heads at two opposite angles, of no very certain species. The artist may have had some native kind in mind, but the surface decoration might suggest the leopard and tiger. A grotesque face protrudes beyond the point of the buckle, which probably amused the red man greatly. Of course heraldic meanings might be attached to every point, adding greatly to its poetic charms, but without awakening any response in the mind of the Indian wearer. Fig. 99 shows an eagle with broadly expanded and conventional tail. One wing is naturally raised, the other conventionally, and considerable ornament is added. This should be dated since the rise of the American republic. Fig. 155 has its counterpart in the Toronto collection; and the writer is inclined to think it an extremely conventionalized variant of the preceding, as may appear by reversing it.

Mrs Converse kindly sent her own interpretation of these brooches, which is much more tasteful and poetic than the prosaic

views of the writer, and will be gladly received by those fond of recondite studies. Of fig. 92 she says:

> This is the most curious and ingenious form. I have never seen a duplicate of this brooch. It symbolizes the totems, or family union and the man, including the story of their warrior ancestors, and tells the story of the union of the Wolf and Bear. The upper figurehead represents the Bear. The lower, the Wolf, united by a human face, signifying the head of the family. The figure of the Wolf terminates in the war club. The Bear holds the war club, and the pin or buckle unites the two. The Bear chief had married the Wolf woman. Both descended from sachems or head chiefs. Fig. 99 represents a combination of the great Eagle, guardian of the dews and war, or sky and earth. At the spread of the tail the small winged symbols indicate his duty in the air. The flat half circles tell the sign of his earth or war office. The simplest brooch is not an accident of the graver's tool. Each stroke is a symbol in hieroglyphs, understood by the expert sign-reader. Fig. 155 is rare, inasmuch as the design is not common. It is the symbol of the warrior. One end forms the tomahawk, the other a war club.

Fig. 86 may be called either pyriform or cordate, the central aperture being the latter, while the opening above changes the general design to the pyriform. There are basal projections, and those at the top suggest the general figure of a crown. The surface is plain. Mrs Converse considers some of the figures above the cordate forms as owls' heads, taking these for emblems of silence and secrecy. This one she describes as a "heart. Owl defined by the open mouth only. Eyes closed." Fig. 87 she calls "very rare. Finely engraved." The writer has seen but one resembling this, and that was by no means as elaborate and fine. The general form is that of a heart with a coronet above, but with unusual surface decoration.

Fig. 95 is another unique brooch, with several half circular projections, and a fanlike ornament above, which may be a variation of the more common form of the crown, surmounting the open heart below. This general plan appears in very many brooches, with endless changes. Mrs Converse thought, this "represents the flaring tail of a bird, yet the heart is on guard in the center. Evidently a totem bird." Fig. 100 is also unique. Both heart and

crown are much conventionalized, and the point of the former is turned to one side and projects beyond the center.

Fig. 136 is cordate, with the base curving to one side. The crown above is hardly recognizable as such at first, and is much ornamented. Mrs Converse described this as "a single heart, surmounted by the horns of a chief, typical of the faithful love of whoever presented it to the chief or sachem." It is a rather frequent form. Fig. 146 is a fine example of the simple heart with an elegant form of the crown. Mrs Converse's interpretation is ingenious: "Horned or chief's brooch; the three branches denote three chiefs in family succession." The triple character of the crown appears in nearly all, there being a small central projection with a broader one on each side. In rare instances there are more.

Fig. 148 has the heart and crown, the former turning aside and ending in an eagle's head. The definition of the owner is pretty: "The eagle defending the life or heart of its owner." A great many of the single or double heart brooches end with eagles' heads, and come within the era of the American republic. It would be easy to interpret them as meaning that the crown or royal rule, through the heart's blood of the colonists freely shed, terminated in the republic whose symbol is the eagle.

Some of the writer's Onondaga brooches will follow. Fig. 94 is fine and perhaps unique. It has the crown and heart form, with the point turned to one side. The crown has no points, and includes a cordate perforation in its center, surrounded by other forms. Its large size allowed more surface decoration than is usual in these. Fig. 96 may be called a double heart, surmounted by a crown in which are several cordate apertures. The basal terminations are two eagles' heads. A friend had one from the Oneida Indians precisely like this, and it is by no means a rare form. Several of the same class are in the writer's collection. Fig. 101 is a little smaller than the last, and the apertures in the crown are crescents and quadrants. It is like one owned by Mrs Converse, of which she wrote: "Rare. A crown terminating with double eagle-headed snake. This serpent has a power over the land and sea. The wavy lines signifying water, the long or land line, and two

dots signify day, sun and moon, or the journey, the rest and the start." This does not agree with the interpretation of fig. 148.

Fig. 105 can hardly be considered Indian work, though obtained from an Onondaga. There is the familiar heart, with some worn ornament at the end, but the pelican above shows a white man's taste and thought. As far as known, it is unique. Fig. 147 is a fine cordate brooch, with a crown resembling in a general way that in fig. 146, but of a more elegant design. This has a little surface decoration. Fig. 149 is cordate, with another form of crown, where circles replace the frequent points. Fig. 151 is cordate, and has the rounded crown with basal points. Several of these differ little except in the apertures.

Some belonging to Onondagas follow. Fig. 83 is a large brooch formerly worn by Aunt Susannah. It is of a kite or diamond shape, with ornamental edges and tracery. Fig. 102 has a generally cordate form and a suggestion of the crown above. It is quite a departure from the typical form, but the resemblance will at once be seen, as in other cases. There are projections at the sides and base. Fig. 103 has much the same character, but has tracery and circular apertures. Fig. 104 is intermediate between these two.

Fig. 137 has the heart with a conventional and elaborate crown. The base curves to one side, and an eagle's head may have worn away. Fig. 140 the writer had from Onondaga. In the center of the crown and on either side are sharp projections. Mrs Converse thought these crowns with apertures were intended for owls' heads, to which they bear a curious resemblance.

Some Tuscarora forms of this class follow. Fig. 93 is of a general diamond form, with undulating edges and four bosses in the margin. There are several apertures and some tracery. Fig. 150 is quite broad for its size, and is a double heart surmounted by a low crown. The basal point curves to one side.

The following illustrations of this class are of brooches from the Allegany reservation. Fig. 97 is a very simple cordate example, with the base turned to one side. The metal forms a narrow band all around the broad aperture. Fig. 141 has the frequent combination of heart and crown, the latter having sharp projections on each side,

three circular apertures in the crown, and some surface decoration. Usually the lower aperture has a double curve, to emphasize the cordate form. Fig. 142 has the feature mentioned, but is otherwise much like the last. Fig. 143 differs in having a projection in the upper circles, thus giving each of those apertures a crescent form. Fig. 145 has the heart with the point turned to one side, and the highly conventionalized crown. Like fig. 137, the latter has no central projection. The surface is covered with tracery.

Fig. 138 is in the Richmond collection, and is a rare form of the heart and crown brooch. Both lower sides have strong cross corrugations, and the crown has a finely crenulated border, as well as the frequent three projections. In the crown are four circular apertures.

Two are shown from the Cattaraugus reservation. Fig. 139 has the usual combination of heart and crown, the two upper apertures having the crescent form. Fig. 144 is one of the neatest examples the writer has seen. The apertures are so formed as to bring out the outlines in the most graceful way.

Fig. 98 is a remarkable Tuscarora brooch, linking this type to the common lyre forms, not long since so abundant. It is large, and has the usual lyre base and sides, but, instead of expanding, it contracts at the top as in cordate forms. Fig. 125 is another small and odd Tuscarora brooch, which is somewhat contracted at the top, and unusually expanded at the base, where there is a short projection on each side.

Fig. 128 is a large lyre-shaped brooch in Mrs Converse's collection, on which she makes this note: "Uncommon. Found in Canada. Two hearts surmounted by a crown, symbolizing friendship." This one is unusually large, but the general type is one of the commonest on the New York reservations. The writer has seen large numbers of them; and, when Major F. H. Furniss was adopted by the Senecas in 1885, his future Seneca mother placed a long black ribbon around his neck, on which were 34 silver brooches of what the writer calls the lyre pattern. This had belonged to Red Jacket's wife, according to tradition. The necklace was considerably over three feet long, and the brooches were about an inch long and $\frac{3}{4}$ of

an inch wide. The original string had been divided some years before, and 15 of the brooches had been arranged on a ribbon in the form of a cross. This was given to Mrs Converse, who was adopted at the same time. The natural inference is that she referred to the size rather than form. Fig. 132 is also hers, but it is smaller and the base is different. It will be observed that what she considers the top of some of these the writer makes the base, thus changing the character.

Fig. 127 is the common size, and the writer had this from the Allegany reservation. It differs from the next mainly in the rounded points and small details of decoration. Fig. 129 was obtained from the same source. Fig. 130 the writer got of the Onondagas. It is slender for so large a size. Fig. 133, obtained with the next at the same place, is also slender and has rounded points. Fig. 131 is a large size, and has a remarkably angular base.

The class of brooches now to be illustrated by a few examples out of very many, is a very curious one, and definitely proves that ornament and not meaning was the great object in the manufacture and use of all. These ornaments, now to be considered, embody the square and compasses, with more or less accessories in the way of decoration, and sometimes these are highly conventionalized. The origin is plain when the resemblance is almost lost and this loss has led to some erroneous interpretations.

A friend writes:

I fail to find in illustrations of jewelry ornamentation of either the French, English or Dutch, designs that have been actually followed in the hammered coin brooch of the Iroquois. In fact, I credit him with entire originality, very curious in some cases, and again there are suggestions of the white man's work ingeniously intergraven with his own conceptions of art not so rude or savage, that it has not developed genius and invention.

This question will not be discussed now; but it is true that the designs of Indian brooches for the most part seem American designs. It is very difficult—perhaps impossible—to find these designs practically anticipated in any other land. So much the writer had reason to believe. Then came a revelation concerning these Masonic

brooches, too many for Indians to use with any reference to their meaning. All these illustrations had been prepared, and work was progressing on these notes, when one day came a catalogue of curios from England, *The Amateur Trader* of Miss Clara Millard, Teddington, Middlesex. No. 4188 of this had an illustration which was the close counterpart of fig. 110 in size, form and details. The description is "XVII. CENTURY masonic emblem, in jargoons and paste. Exact size. £2 12s 6d." Was the Indian silver brooch copied from this, or this from the brooch? The same question might be asked of other forms. The silver brooch of the Indians did not exist in the 17th century, and the age of the above ornament may also be doubted.

After this was in print a learned German friend pointed out to the writer several brooches of what he said were Scandinavian and other types in his collection, but there has been no time to study the subject, and illustrations of this are not now recalled.

Out of a large number of these Masonic brooches, over a score have been selected for illustration, in themselves far more in number than all the Indian Free Masons known. Joseph Brant was a well known member of the fraternity, and Red Jacket has been claimed. There may have been a few others, but these were common ornaments. The writer has nine still in his collection, after parting with some to his friends. He might easily at one time have trebled the number. This abundance is proof that they had no significance to most of their wearers.

Fig. 124 was the first of these that attracted the writer's attention, and it now belongs to the Masonic Veterans of Central New York. The base is a half circle with ornaments, and above this the square and compasses are plainly seen. This was long worn by Aunt Dinah, a very old Onondaga woman. Traditionally it first came from Brant's family to her, and was naturally supposed to be a jewel worn by him. Now that the form is known to be so common, this may be doubted.

Several examples follow from Mrs Converse's fine collection. Fig. 108 adds many things to the simpler form, which is easily detected under these accumulated ornaments. Several fine bosses add to its effect. The forms of apertures used in this appear in several

others. Fig. 110 is a smaller and simpler form, almost identical with the English one mentioned except in material. Like that, it has a curved base, and the sun and moon between this and the square. Another interesting thing in connection with this is mentioned by Mrs Converse. She said: "It was given me by the grandson of Red Jacket. It proved from that Red Jacket was a Mason, and wore this brooch for pass. In further investigation, while working at the Red Jacket monument at Buffalo, I heard of a man who had sat in a lodge with the great Sa-go-ye-wat-ha." The brooch hardly proves this, the other evidence is hearsay, but, if Red Jacket was a member of the craft, it would appear on some of its records. He was too well known to be easily overlooked in such a matter.

Fig. 113 is smaller and less elegant, but has the same features in a more conventional way. Fig. 117 is larger and more elaborate. Fig. 119 is one of the simplest forms, having but two apertures, but these are large. The surface is covered with tracery. Fig. 120 is quite conventional, but the leading features of other forms are readily detected. Fig. 126 is simple, with but little surface decoration.

Fig. 109 is a Seneca brooch, differing from some other elaborate ones only in minor details. This has six bosses, which are smaller than in most others. This and the next are in the Richmond collection. Fig. 114 is a large and quite frequent form with many accessories. By omitting the outside loops the design would become much like those of a simpler and more distinct character, a fact easily tested. Fig. 106 shows a fine example from the Tuscarora reservation, having 15 large and small bosses. On either side, at the top are angular projections, terminating in embossed ends. These adjuncts belong to several. Fig. 111 is in the Richmond collection, and presents the feature mentioned in a less common way.

Fig. 116 is in the Buffalo collection, and is one of the rarest of these small forms, as well as one of the most beautiful. Did it stand alone, its character might not be understood, but in a series this is evident. The base has a border of small bosses, except in the middle, and the lateral projecting points at the top are terminated by others. The tracery adds some peculiar features to the design.

What was said of the character of the last seems partially true of the Tuscarora brooch in fig. 122. Its Masonic character is extremely obscure taken by itself, but a comparison with others on the same plate reveals a strong likeness to them.

Fig. 112 shows a very fine embossed brooch at Onondaga, having projections at the base. All vary in details and somewhat in outline. The simpler forms have a uniformly curved base; others add various ornaments.

The remaining illustrations of this class are from the writer's collection. They are usually large and have been quite abundant. Fig. 118 is highly conventional, but otherwise quite plain. Fig. 107 is the smallest that has met the writer's eye. It is embossed, and has the general character of some of the larger forms, but the base has a series of broad curves between the bosses. Both these are from Onondaga, and all but one of those which follow. Fig. 115 is a frequent and rather plain form, with some conventional features. The writer obtained four of these out of a number like them. Fig. 121 shows the original features of the class more plainly, and is very neat in design and finish. The base is a simple curve. Fig. 123 adds the interior bars found in several others, and has projections at the base. Fig. 152 was obtained at Cattaraugus, and is an elegant ornament in every way. At the top it has the rare feature of red glass neatly set. Fig. 159 shows one belonging to Mrs Converse, which has a glass setting near the center of the base. It is quite conventional. The glass setting has been observed in very few. So many of this class remain that the numbers must once have been great

One fine and unique article, obtained by the writer from an Onondaga woman, is shown in fig. 223. It is a large silver pendant, with a center of green glass of diamond form. The edges of the pendant are parallel with this, but have broad expansions opposite the angles of the glass, giving it the appearance of an equilateral and massive cross.

A few examples are given of a class once very abundant, and much used for adorning ribbons. They differ very little in outline, but very much in details and size. The figures illustrate the largest and smallest in the writer's collection. They might be called either quadrilateral or octagonal, for the broad angles form four short

sides having indentations. The sides proper consist of two bars, concave in outline, uniting so as to form a broader, ornamented surface at each angle. The buckle crosses from point to point. Those represented are all from the Onondaga and Tonawanda reservations. One unique form is not described.

Fig. 164 is the smallest the writer has seen. The angles are ornamented with lines and small circles. Fig. 163 is the largest in his collection, and may be as large as any. The surface ornaments are like the last, but the divisions of the angles are more protuberant than usual. Fig. 161 has surface ornamentation nearly all over. Fig. 162 is plainer. Fig. 165 and 167 have both bars ornamented, but not the angles. They are among the handsomest collected. Fig. 166 is much like these, but the angles are ornamented.

The writer has a few simple silver brooches, which are open and almost as slender as those which are simple rings or round buckles, but they are angular. Fig. 134 shows one of these which is square, but with the angles rounded. The tongue of the buckle reaches from one of these to that opposite. Fig. 135 is a similar one which has the angles indented.

The Onondagas call the brooch *Ah-ten-ha-né-sah,* shining ornament.

Headbands

The silver headband is a long strip of sheet silver, straight on the lower edge but usually with points of some kind on the upper, and with some pretty pattern between. The Onondagas call these *Ta-yone-non-aich-han-hust'-ah.* The whole headdress, which once often included this, was called *Gos-tó-weh* by the Senecas. Part of this, as given by Morgan, but without feathers, is shown in fig. 157. Quite commonly, however, the headband encircled an ordinary hat, and in this way the writer has seen several used by one person, one being placed above another. Usually the wearer had but one, which served as a foundation for other ornaments. They were secured by strings in the holes at the ends.

They are now difficult to obtain. The writer's inquiries on several reservations have been unsuccessful, nor can they now be found among the Iroquois of Canada. That the State Museum has now several of these rare articles is due to the intelligent zeal

of Mrs H. M. Converse, whose opportunities have been exceptionally good, and whose own fine collection of silver ornaments is well known.

Fig. 386 is a Seneca headband drawn by the writer, and reduced from the actual size, like all those which follow. The six others illustrated are in the State Museum, and were carefully drawn there from the objects themselves. They are faithful representations of these.

Fig. 399 is $1\frac{3}{4}$ inches deep. The upper edge is cut into half circles, inside of each of which is a triangular perforation. Alternating with each of these, below is a line of vertical hearts, cut through the band. Another line of narrow openings is below these. Fluting and tracery elsewhere adorn the surface. Fig. 400 is narrower, and has embossed points on the upper edge. There is a central row of narrow elliptic openings, and some tracery. Fig. 401 has similar points above, narrow elliptic openings below these, and a line of open hearts farther down alternately point toward each other. Fluting and tracery also appear. This is about $1\frac{1}{2}$ inches deep.

Fig. 402 is of the same depth, and has broad crenulated lobes above with tracery following the outline. In the center of the wide lobes are kidney-shaped or broad cordate perforations, pointing upward. Below each of these is an open diamond, cut horizontally and with a boss at each angle. Alternate with these are open hearts pointing upward. Fig. 403 is a narrow and simple band, the only decorations being fluting. Fig. 404 is $1\frac{3}{4}$ inches deep, and has very broad crenulated lobes above. There is a central line of alternate perforated stars and diamonds, with some fluting and tracery. The state collection of these is a very good representative one, but among those formerly used there must have been a great variety of detail.

Miscellaneous

Some ornaments occur which can not be classified. Fig. 156 is one of these, and was found on Indian hill in Pompey in the year 1901. It is of pewter and is V-shaped, with the angle rounded. There are protruding angular points and bosses. Another of similar character has more the form of a buckle. Broken iron, brass, and pewter buckles are sometimes found.

A handsome ornament of variously colored beads was also plowed up on Indian hill in Pompey the same year. The beads were kept in place by the brass wire on which they were strung. There was a large circle of these, with several pendants of beads attached. In 1902 the writer found there other glass beads, preserved on brass wire.

Fig. 224 is a large open heart of brass wire from Fort Plain. A wire loop is soldered in the angle above. Fig. 225 is a heavy copper pendant, found on the sand plains near Rome N. Y. Of this two views are given. The disk below has a large ring in the heavy loop above. This may have been of the 17th century, or early in the 18th.

Of about the same date is a fine brass ornament in Mr Stanford's collection, 3¼ inches long by 1⅓ wide. The upper half is lyre-shaped and open; the lower open and circular, but with a projection at the base. Both halves form one piece. In the openings hang open, six pointed stars, nearly filling the space. Fig. 395 shows this. It suggests an ornament from harness.

Fig. 285 is from Indian castle in Pompey, and is a flat and narrow piece of brass, rounded on the upper surface and terminating in a trefoil at the broader end. Near that end is an elliptic perforation, which may have been for attachment or suspension, but probably the former. Fig. 380 is a broader article of the same kind, and from the same place. The lobes of the trefoil are rounder, and the perforation is circular, as in most other cases. Still another is from the same place. In every case meeting the writer's eye, the base has been broken.

The Onondaga specimens might have been worn in the hair or attached to the dress, being straight. Mr Stanford's specimens, at Munnsville, require a different view. In two of these, longer than those from Onondaga, the base is abruptly bent upward. Each of these is about 4¼ inches long. A third is of quite a different character, and not far from the same length in a direct line. Two abrupt curves make the actual length much greater. Viewed from the side, it suggests the curved handle of an old-fashioned door-latch, or the handles sometimes used with shawl straps. About the middle of this curve it is nearly ¾ of an inch wide. There can be little doubt that this was an ornamental handle of some kind. The others may have had a secondary use after being broken.

Fig. 286 is a neat little article of brass, found a mile west of Canajoharie. The portion ornamented with cross lines has the outline of a broad trowel, and there is a narrow rectangular base. There are no present means of attachment, and it may once have been longer, though showing no signs of breakage.

Fig. 287 is a slender and angular piece of copper, which is evidently a fragment. Its general form suggests that it may have been one of the tobacco tongs, often given to the Indians. This came from Indian hill in Pompey. A heavier one, of slightly different form, is in the Stanford collection.

One odd relic from a recent Cayuga site is a silver watch seal of considerable size. The handle is in the form of a dolphin, and the seal has crossed arrows between the letters K. M. This might have come among the spoils of war, by gift or purchase. With its Indian owner it was merely a pretty ornament, easily suspended and worn. Such an object would be attractive to any savage mind when plunder was to be had. But nothing that an Indian might carry off need excite surprise. When the Huron towns were destroyed in Canada in 1649 and 1650, and two of the missionaries were killed, the Onondagas carried off two little books belonging to the latter, and Father Le Moyne recovered them at Onondaga in 1654.

Though not ornaments, there are figured here several unique recent copper relics which have been lent the writer at the last moment. They are in form like the old bone needles, flat and perforated, and of interest as a survival of an early form in a later material, like the conical and triangular arrowheads of copper. As nothing of the kind has ever been described before, it seemed best to include them now. These are from Indian hill in Pompey, and they have been reported from no other place. They are about as thick as needles of bone, but rather wider than most of these. Fig. 376 is broad, and is broken at the perforation. Fig. 377 is narrower and has a rounder point. It had two perforations. Fig. 378 is longer, and has a long and narrow hole. Fig. 379 is unperforated, and is pointed at both ends. Such needles have been used in netting snowshoes. These have since been placed in the State Museum. Their age is not far from 250 years, and they are all that the writer has anywhere seen.

Addenda

Since the bulletin on bone articles was prepared, a number of interesting relics have been reported. The finest of these are in the small collections of L. William H. Klinkhart and his friends, in Canajoharie N. Y., and were all found in that vicinity. The writer has examined some of them. One small and broad bone comb has three human heads projecting above the upper rim in a curved line. This is about 1⅜ inches high. Another terminates above in a long-bodied quadruped in a standing posture. Below the opening are two human faces. This is more than double the length of the last, being over 3 inches high. It is from Wagner's hollow. Another may be a pin, or part of a comb with a single long and perfect tooth remaining. One tooth certainly has been lost, but the fracture has been repaired, and the part is neatly finished where it might have widened into a comb. The top curves, and two human faces are in the open work below the upper rim, as in the last. This fine article is 3⅝ inches high, and came from the Otstungo site. Its importance is in showing the resemblance of some work on this early site to some of clearly historic date.

A human figure of horn has the hands under the chin, and the head is disproportionately large. It is 2½ inches high and was found at Wagner's hollow. There are the usual awls; perforated beaver and elk teeth, cylindric bone beads, perforated deer phalanges, some of which are fine. The longest awl is over 8 inches in length. One conical bone point has a lateral perforation. This article is over 3 inches long, and came from the recent site in Rice's woods.

One fine bone harpoon has two long barbs on one side, and is perforated. At the broad base are longitudinal grooves, like those on a harpoon of Mr Richmond's from the Mohawk valley, but more and longer. Another of the same length is about half as wide at its plain base. This has two barbs on one side, and on that edge is a projection in which is the perforation. These notable harpoons are each 6⅜ inches long, and come from Wagner's hollow, where others have been found.

The occurrence of a much worked *Fulgur carica* on the Cayadutta site is of interest, as marine shells are rare on early Iroquois sites in New York. The base, outer whorl and some projections have been cut away, and a long slit cut in the remainder toward the base. The

whole shell shows age. This was found by Mr Percy M. Van Epps of Glenville. In his collection and those of his friends, the writer found many interesting articles, mostly of stone. As the Mohawks had no towns in Schenectady county, pottery is rare there, as well as recent articles.

The Bigelow collection has received a number of the curious ornaments made from the concave and convex ends of bones, pierced for suspension. They are from Pompey sites of the pre-colonial period. One retains traces of red paint. One massive and carved bone bead is from the Christopher site. Mr Bigelow has also recently obtained a fine tube from near Three River Point, and a banner stone from Savannah N. Y. Both are of striped slate. A bayonet slate weapon and a remarkable flattened bird amulet are among his recent additions.

Mr Theodore Stanford, of Munnsville, has a fine cylindric bone arrowhead with barbs, and also a worked bone, about half as thick as wide. This is 3 inches long and an inch wide at the broad end, which is notched all around. Near that end is a lateral perforation. The general form is flat, with rounded edges.

The writer has also examined Mr R. D. Loveland's fine collection in Watertown N. Y., which is rich in clay pipes from neighboring forts. A few have stems fitted to bowls which were found on the same sites and are of the same character. They are not always certainly parts of the same article, though of the same age. Some perfect examples are unique, as well as some imperfect. One of the former, a small clay pipe, is like a high shoe in outline, but much compressed. Dr A. A. Getman has a broken one of similar form. In September 1901, the writer was present when Mr Oren Pomeroy took out of a Jefferson county camp site a fine clay pipe bowl, having a human face before and behind. This form is rare. On the same visit, Dr R. W. Amidon presented him a small clay pipe bowl, perforated for the insertion of a stem.

In the Loveland collection one peculiar long and broad flat awl has deep notches on each edge above the base. Another fine example has been beautifully mottled by fire. A bone arrowhead is one of the remarkable articles in this collection. It is angularly shouldered but not strictly barbed, and has a long and moderately slender perforated tang. Recently Mr Loveland obtained a pipe

resembling fig. 220 of the bulletin on earthenware, with several fragments. Three examples of a curious canoe-shaped pipe bowl have also been found by him. Unio shell beads are also now in his collection.

Two articles are of high interest, though simple, and will be illustrated later. They are of carved wood, which fire has charred but not destroyed. With one exception they are probably the oldest remains of this kind in New York.

Several interesting collections have been examined in and about Glenville N. Y., through the kindness of Mr Percy M. Van Epps. In one of these is a woman's knife unfinished, of the red slate of Washington county, showing that it was made not far away.

Several fine bird pipes of stone have been found, one of which is in Col. Camp's collection at Sacketts Harbor, the gem of which is a massive and highly polished stone pipe resembling a flying squirrel. It is 6½ inches long, by 2⅝ broad. He has also a thin and highly polished stone tube. A beautiful shell gorget comes from Savannah N. Y., and is nearly 4 inches across. Other interesting finds will not be mentioned now.

At the last moment a supplementary note seems required. In September 1903 Mr John Mackay, of Niagara Falls, opened an ossuary of the Neutral nation close by the Tuscarora reservation, of the approximate date of 1620. Iron axes and brass kettles were found in this, shell and metallic ornaments, sword blades and pipes, with a few glass beads. The metallic beads were made from strips cut from old kettles and rolled into cylinders, from 2 to 11 inches in length. Of more interest were 24 rude rings of the same material, most of them rolled into cylinders and bent into a circular form. A flat one served for a finger ring and still encircled the finger bone. The others were larger, from ⅞ to 1¾ inches across, some overlapping and some just meeting at the ends. A large one is 2½ inches across, doubled, beaten flat, and then brought into a circle like the rim of a hat. A strip of metal is folded over the ends and also beaten flat.

The writer obtained one unique brooch too late to figure or describe, to which reference has been made on page 94. It may be called of a diamond form, each side being a narrow bar, curved over outside at each end and forming a short hook. It measures 1⅛ by 1½ inches.

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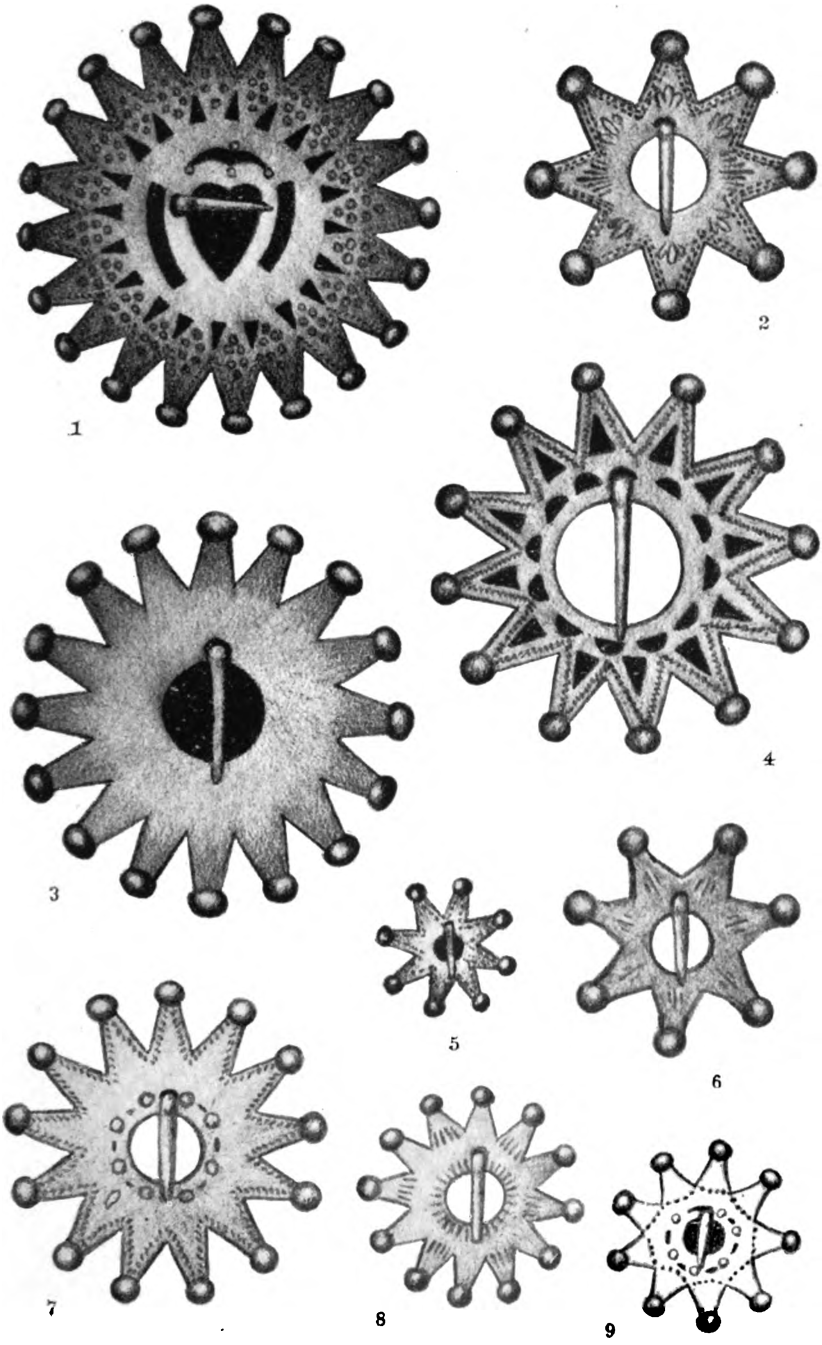
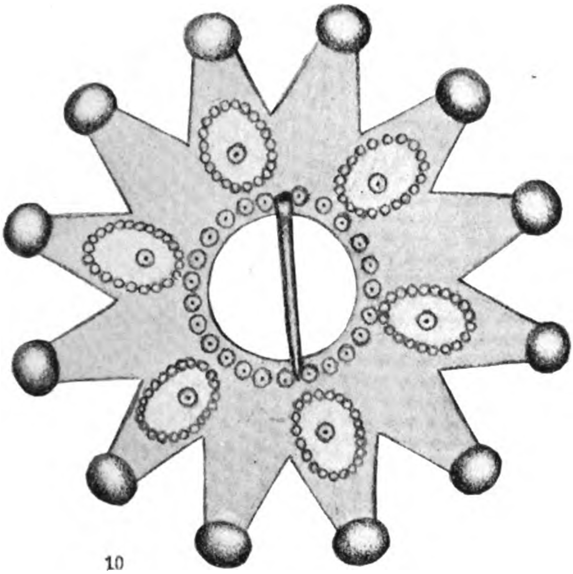


Plate 2



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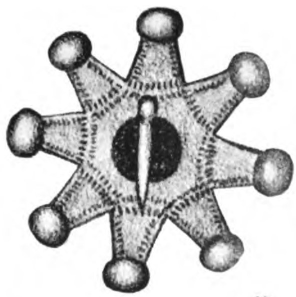

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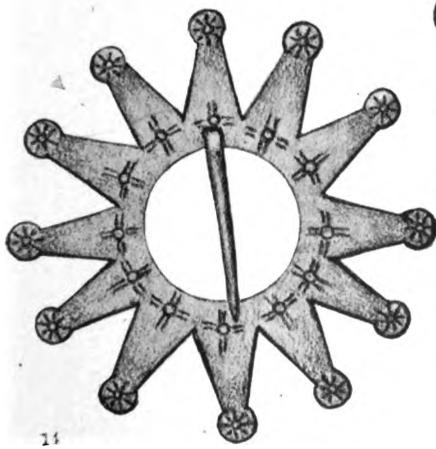

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Plate 3

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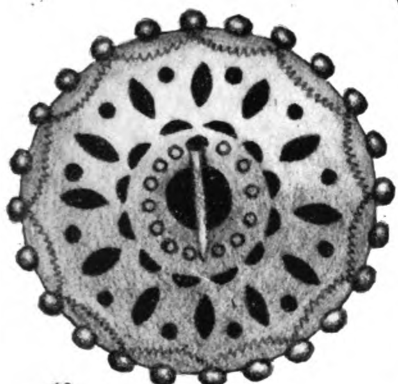

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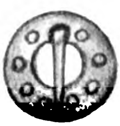

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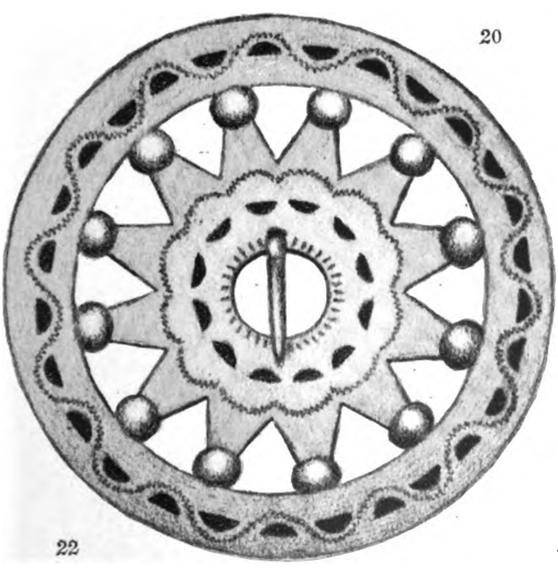

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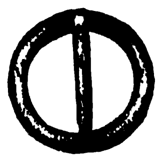

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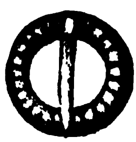

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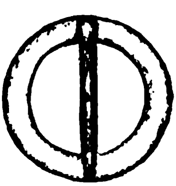

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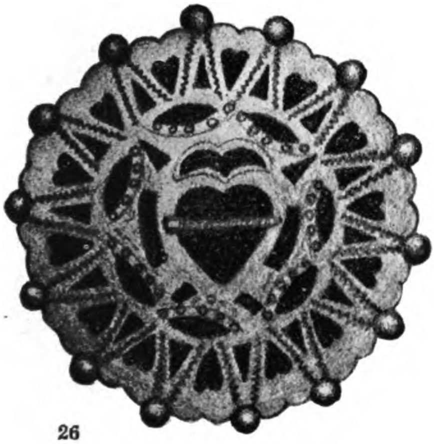

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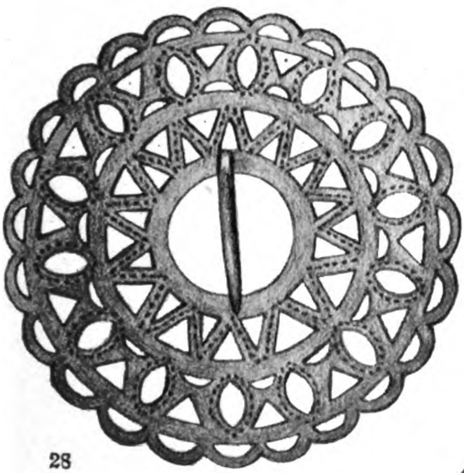

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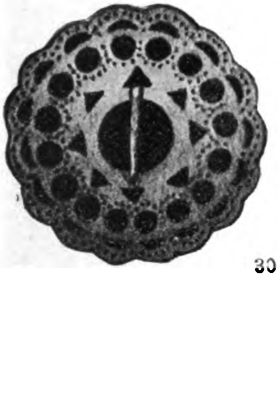

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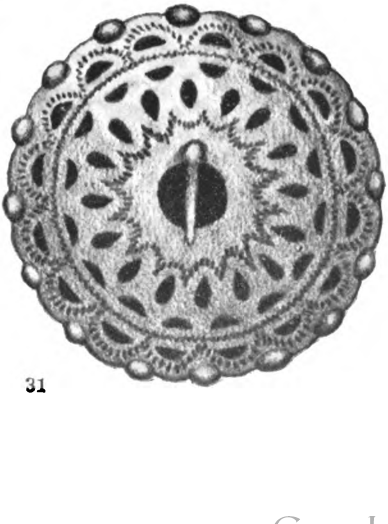

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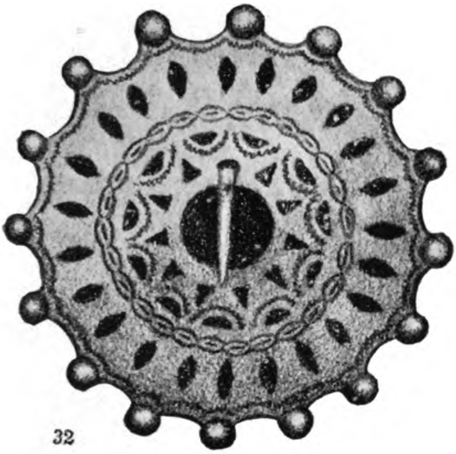

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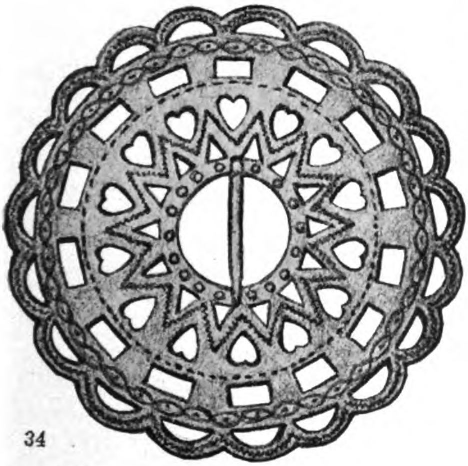

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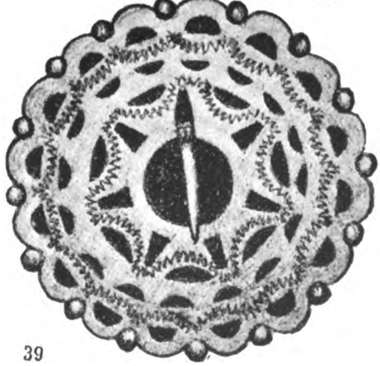

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Plate 6

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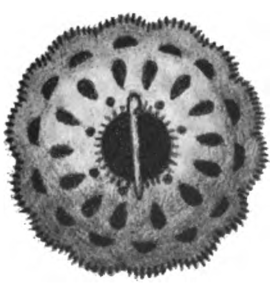

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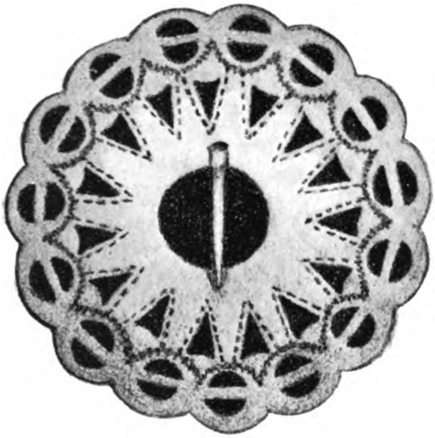

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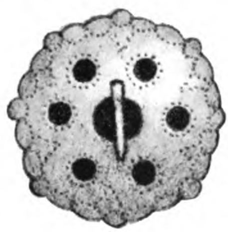

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Plate 8

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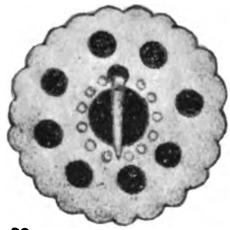

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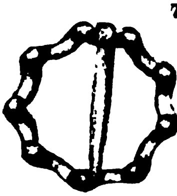

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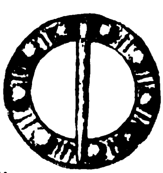

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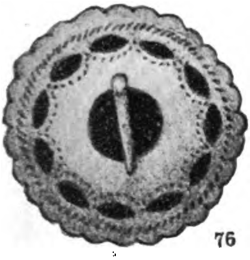

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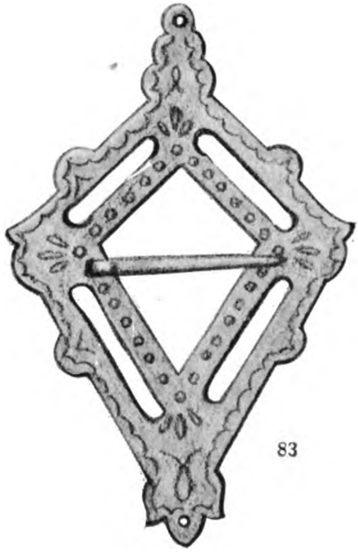

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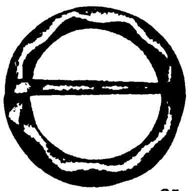

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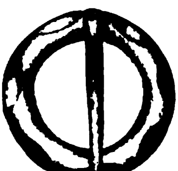

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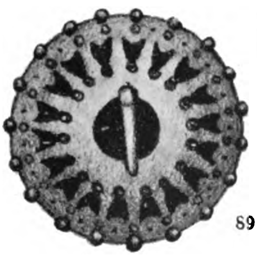

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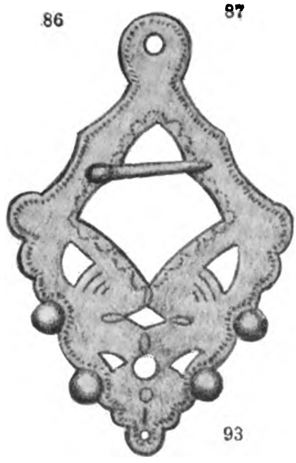

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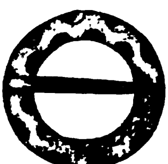

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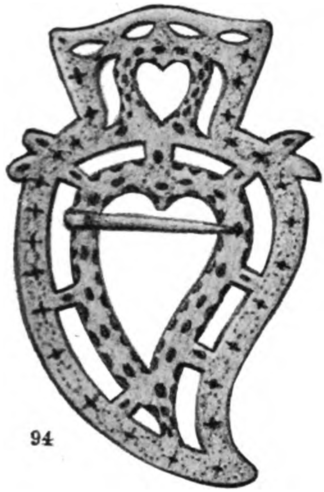
Plate 10



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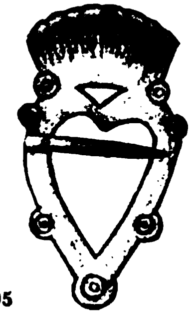

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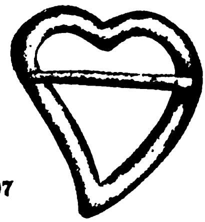

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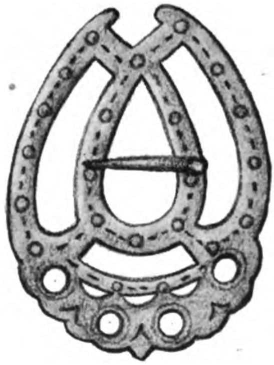

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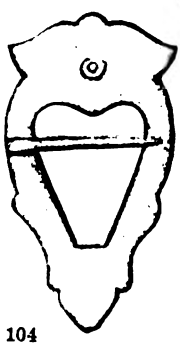

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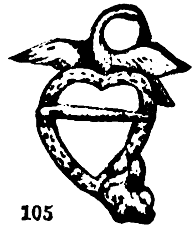

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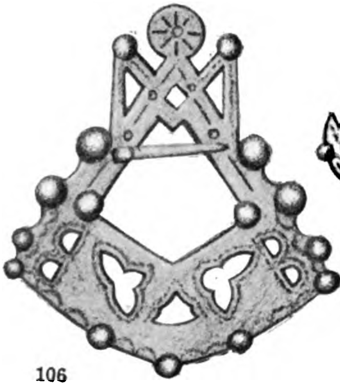

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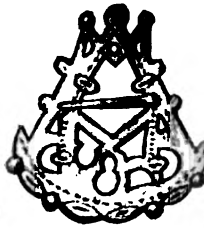

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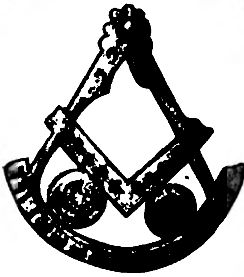

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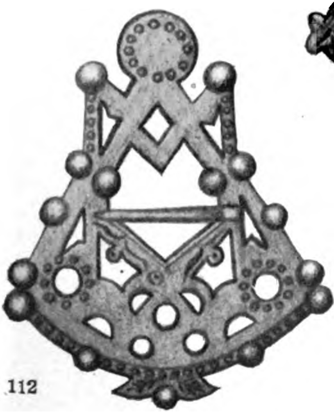

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Plate 12

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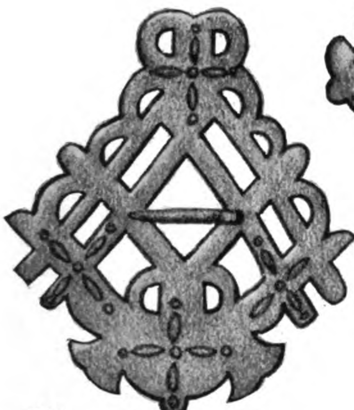

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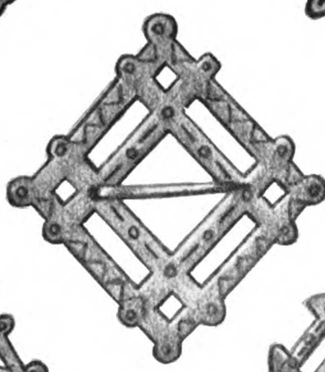

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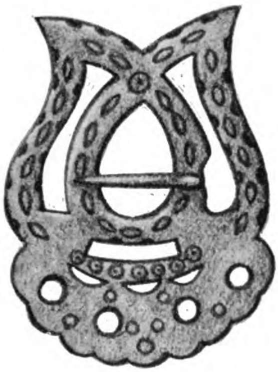

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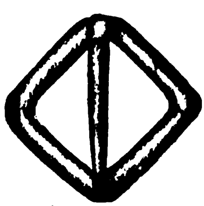

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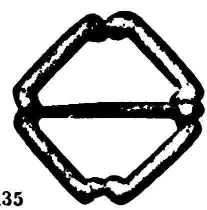

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Plate 14

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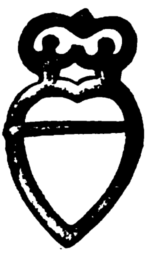

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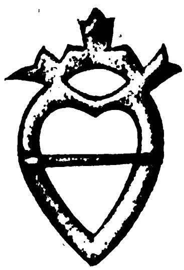

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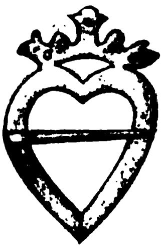

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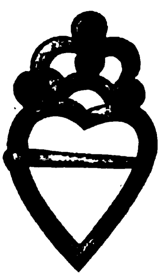

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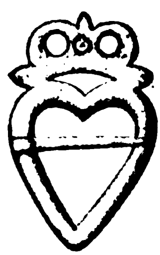

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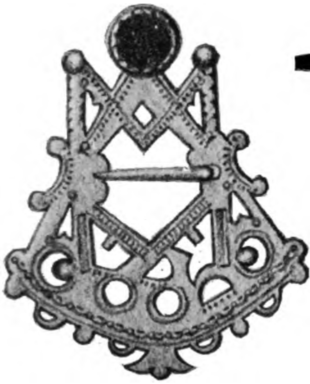

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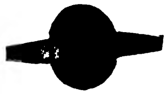

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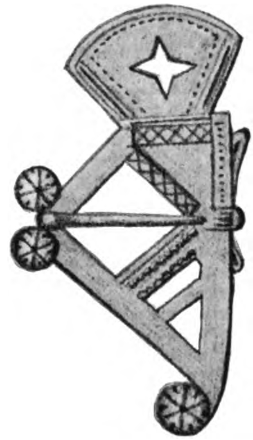

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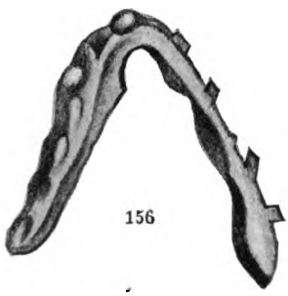

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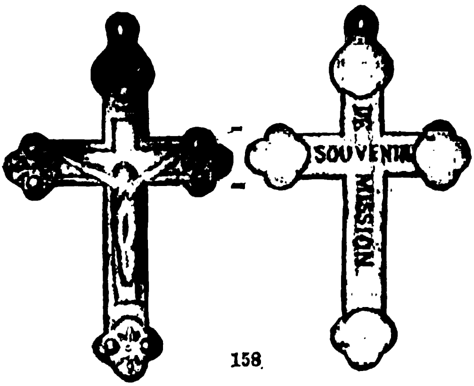

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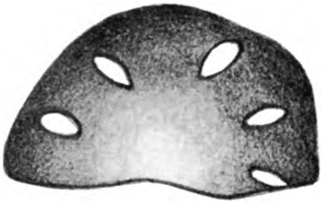
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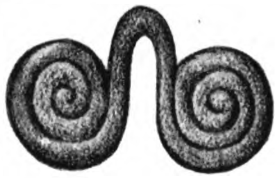
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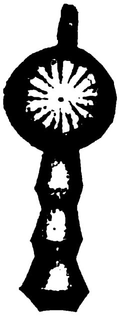
Plate 17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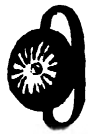
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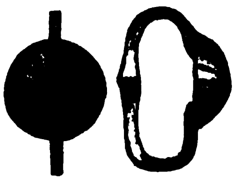
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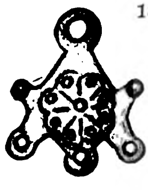
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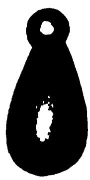
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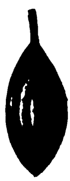
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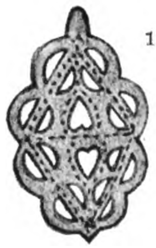
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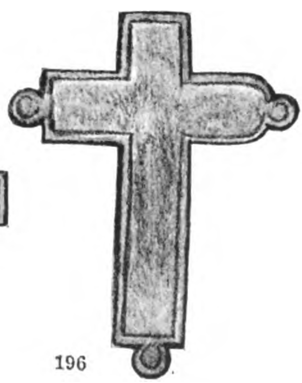
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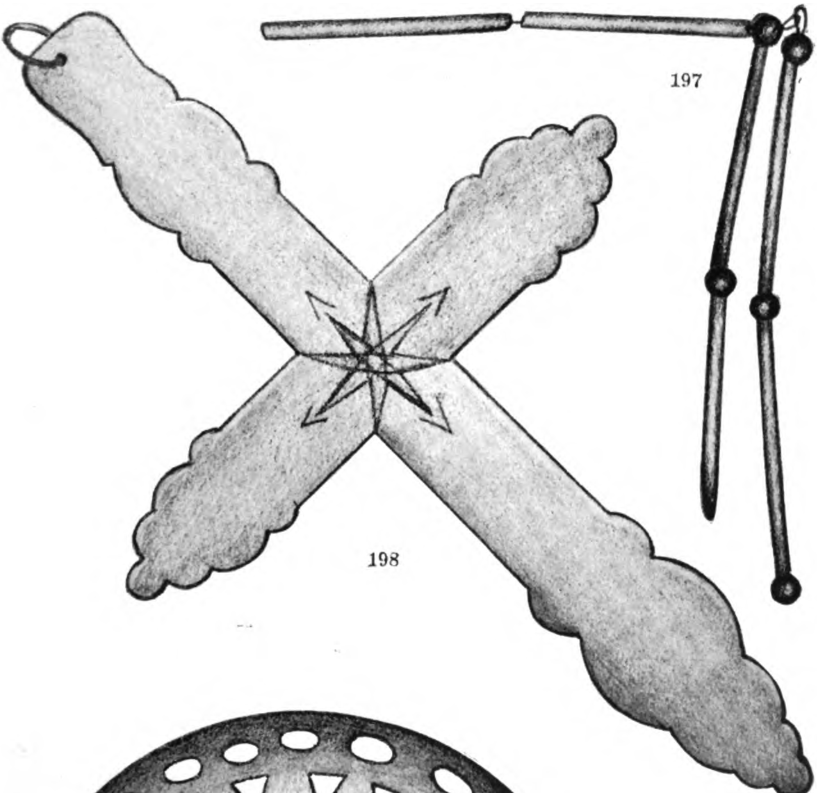

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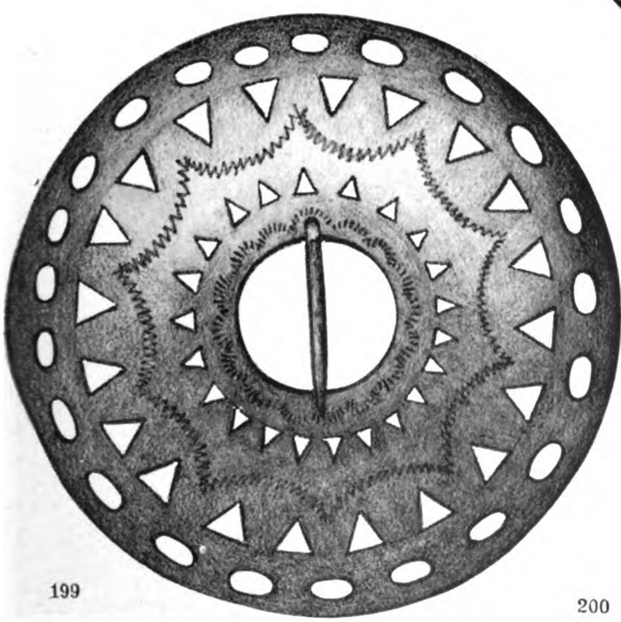

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Plate 19

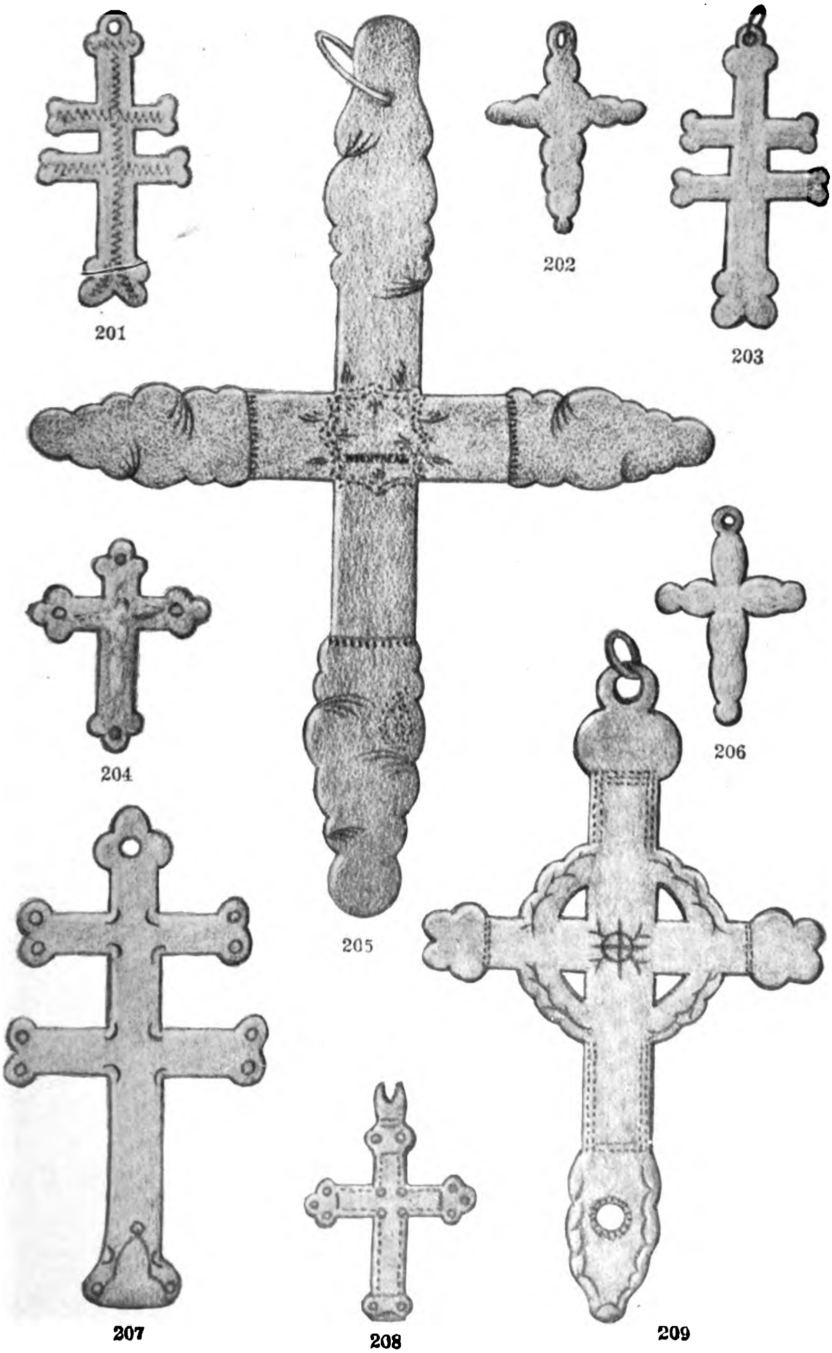

Plate 20

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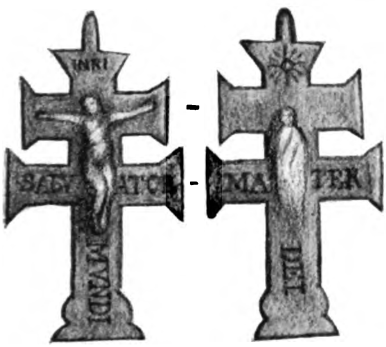

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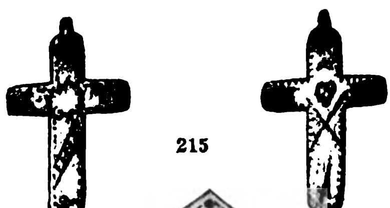

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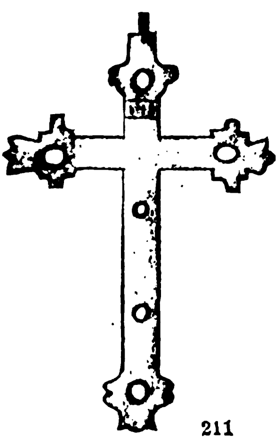

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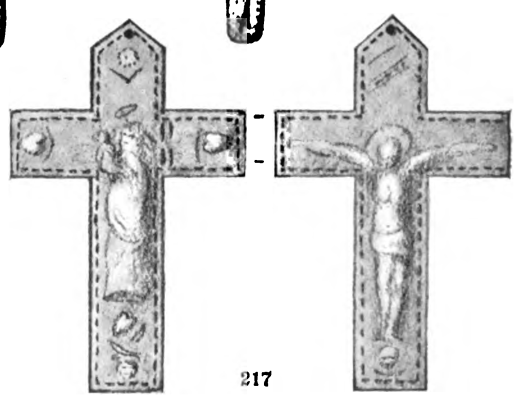

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Plate 21

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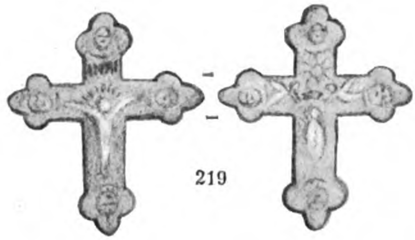

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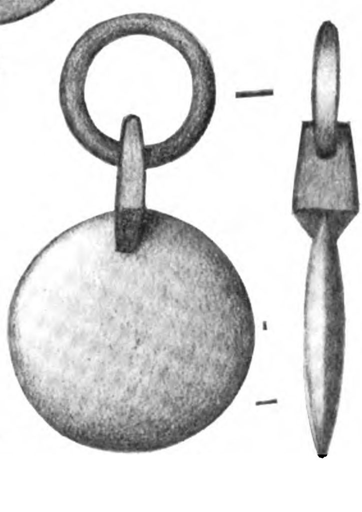

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Plate 22

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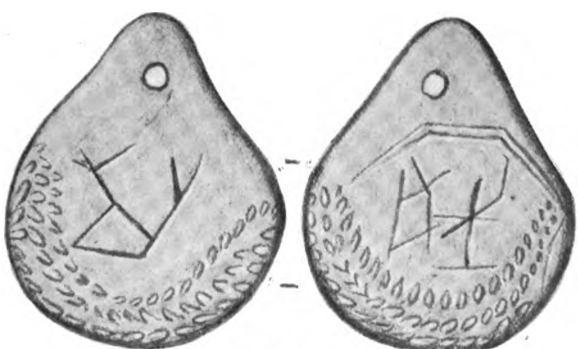

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Plate 23

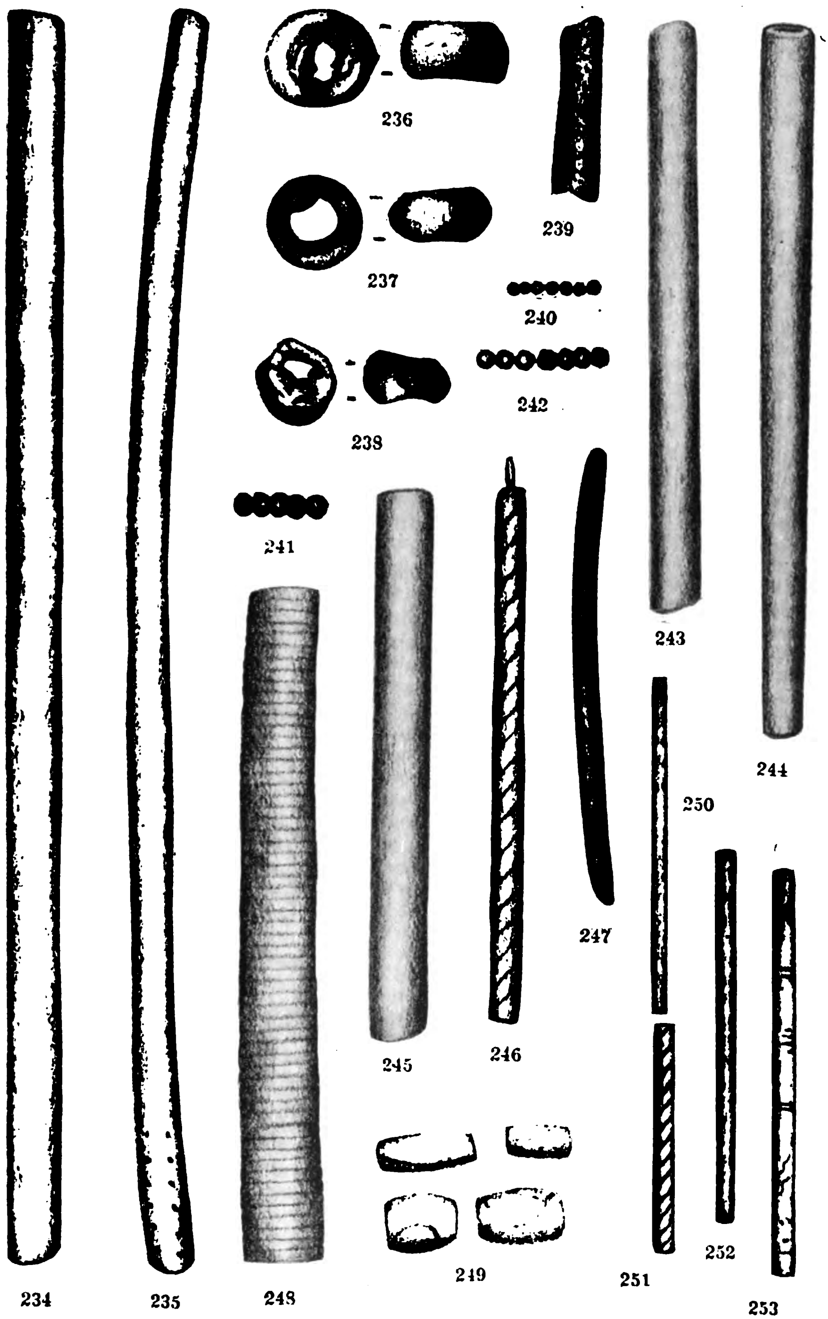
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Plate 24

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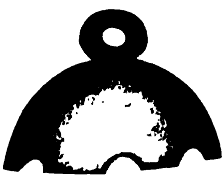

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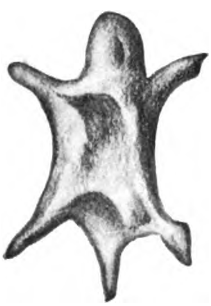

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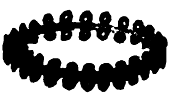

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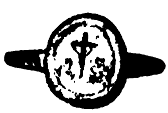

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Plate 26

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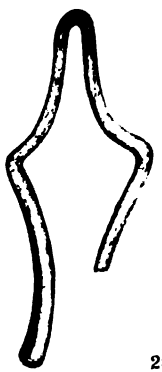

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Plate 27

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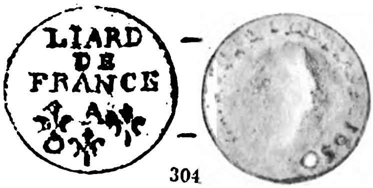

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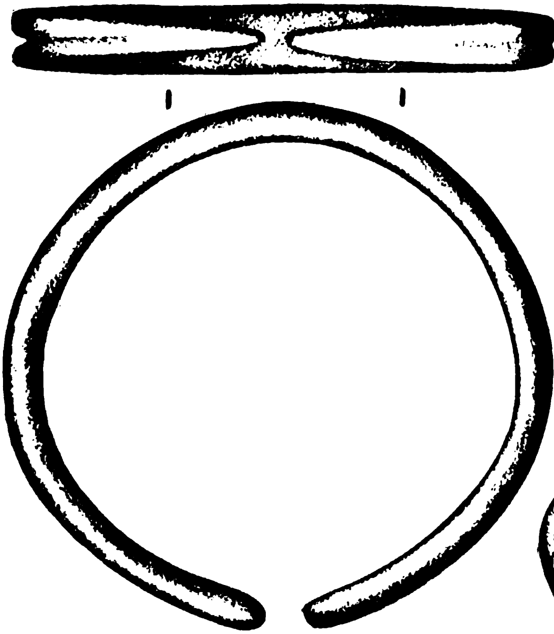

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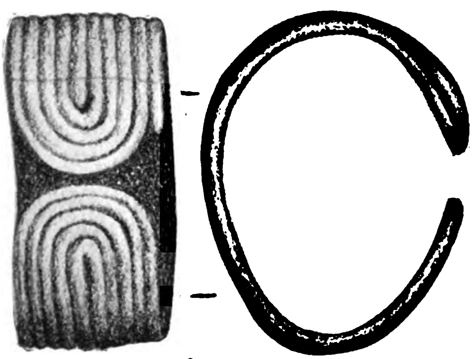

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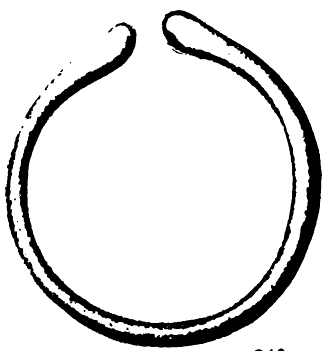

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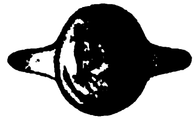

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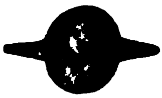

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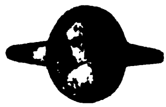

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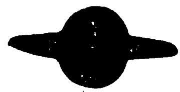

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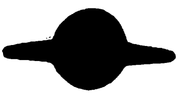

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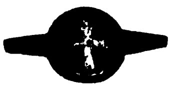

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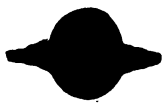

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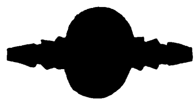

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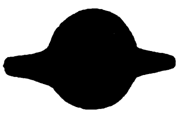

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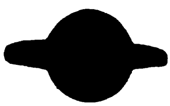

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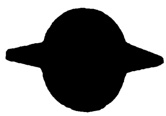

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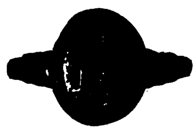

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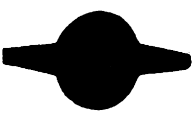

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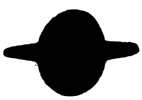

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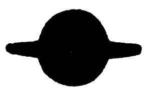

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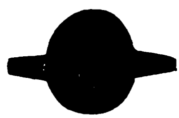

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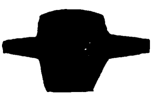

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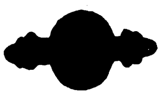

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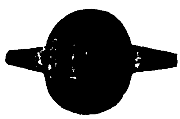

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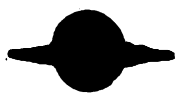

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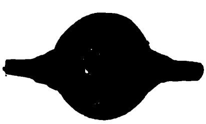

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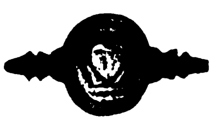

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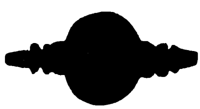

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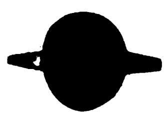

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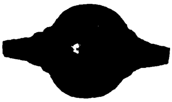
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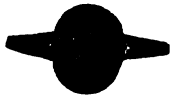
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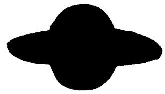
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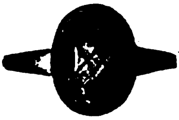
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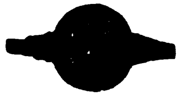
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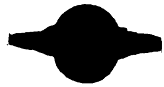
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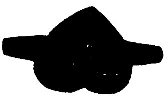
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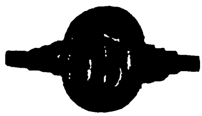
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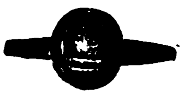
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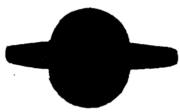
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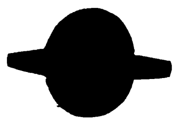
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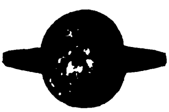
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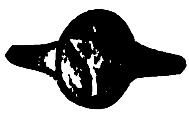
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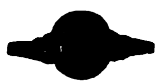
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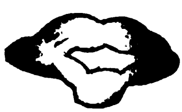
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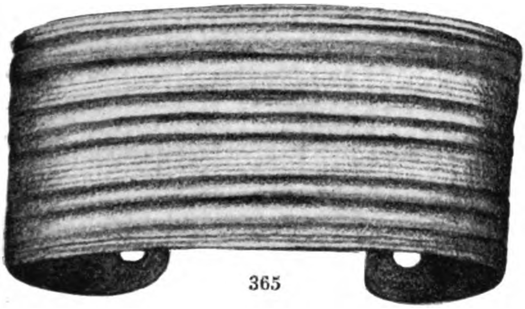

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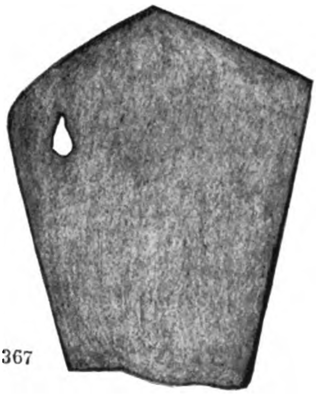

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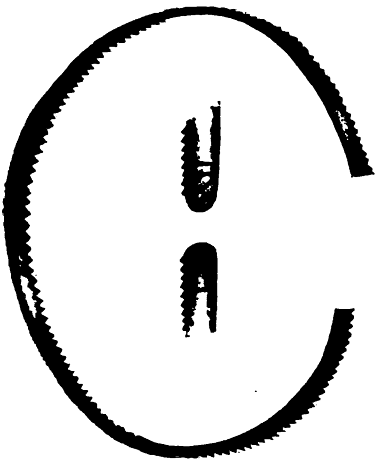

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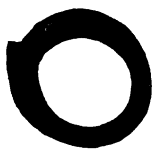

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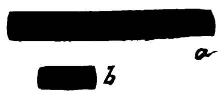

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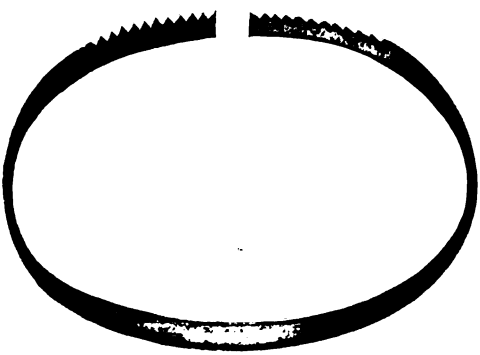

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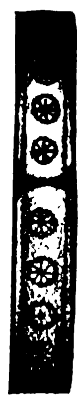

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Plate 32

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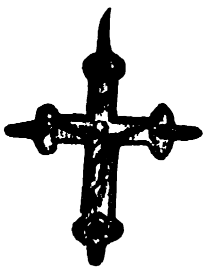

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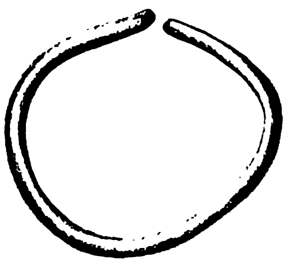

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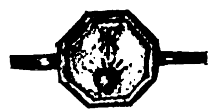

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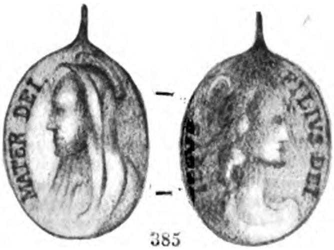

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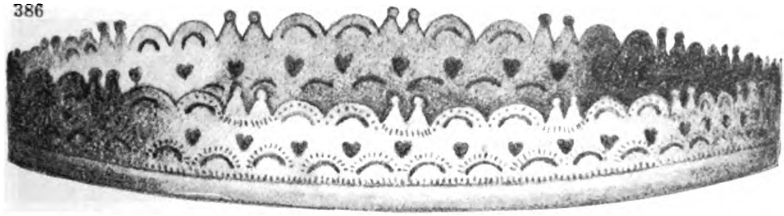

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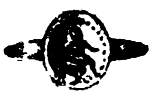

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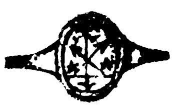

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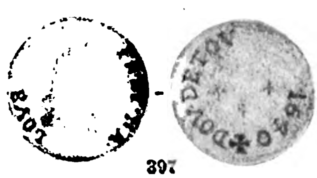

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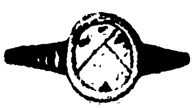

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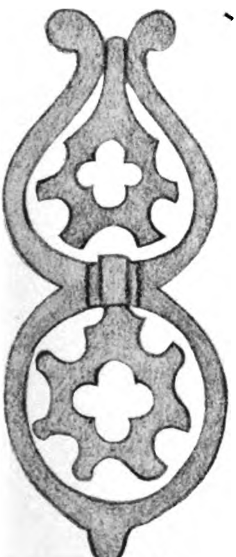

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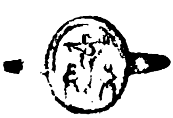

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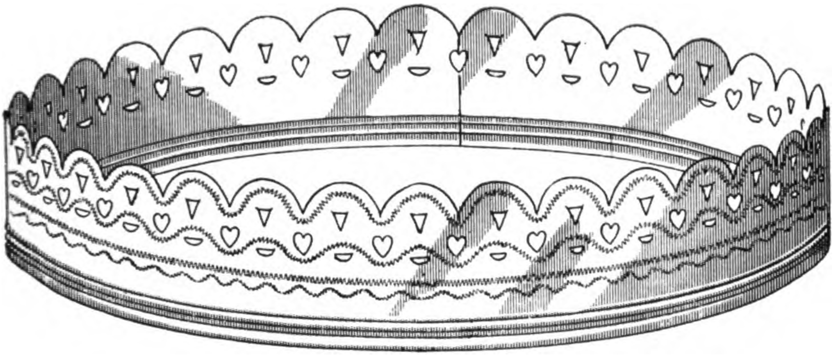
Plate 34



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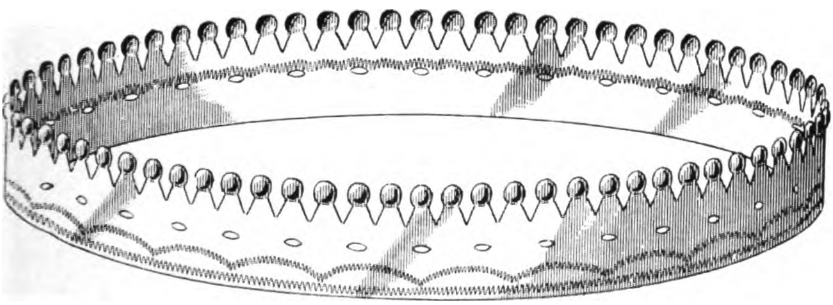

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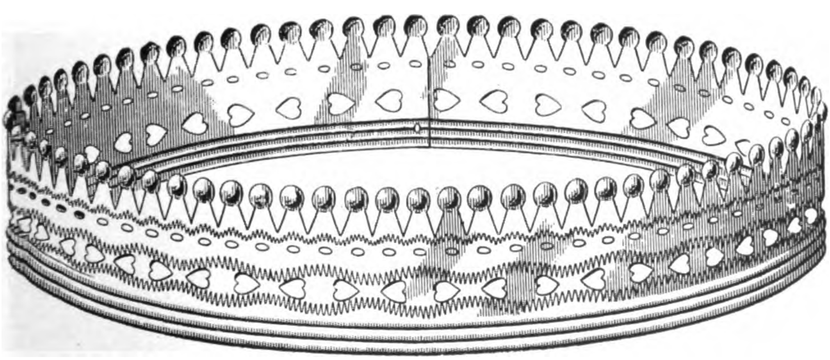

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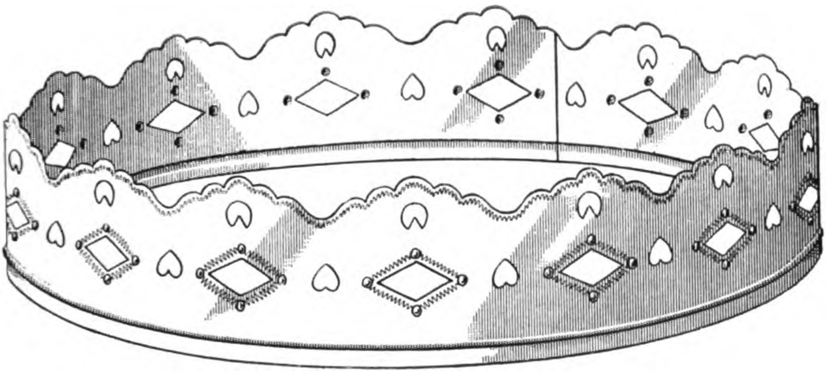
Plate 35



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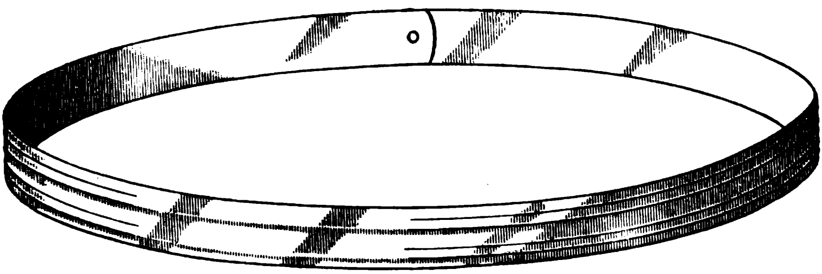

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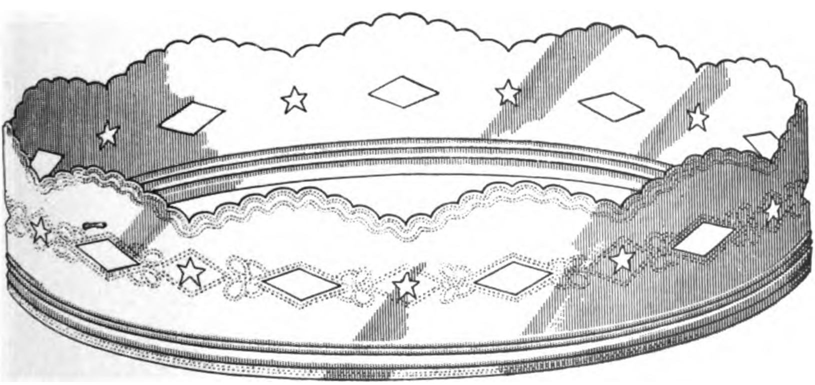

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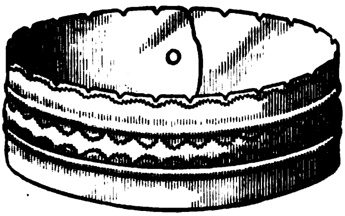

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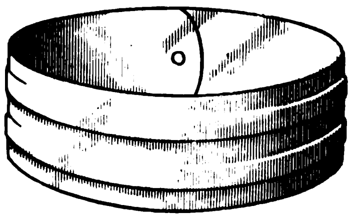

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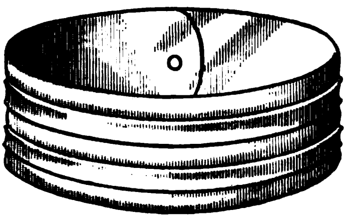

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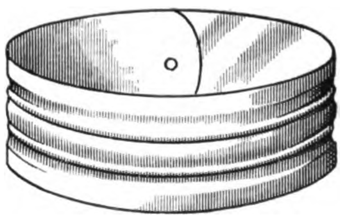

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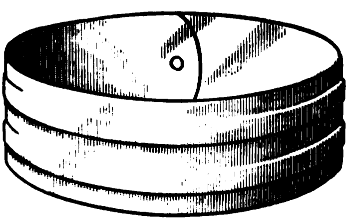

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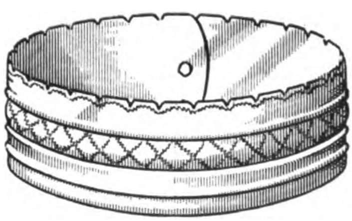

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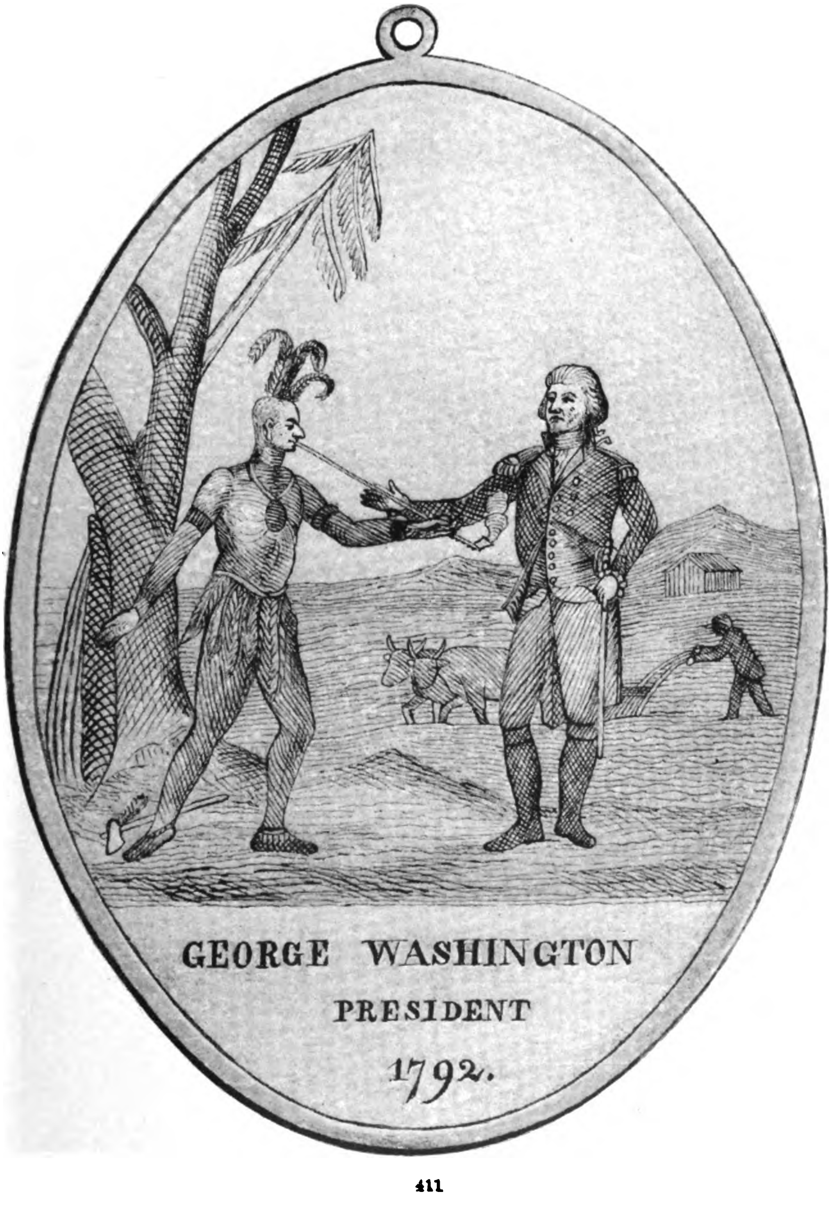
GEORGE WASHINGTON
PRESIDENT
1792.

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New York State Museum

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18–19	51 "	32–34	54 "	45–48	" v. 4
				49–54	55, v. 1

The figures in parenthesis indicate the bulletin's number as a New York State Museum bulletin.

Geology. G1 (14) Kemp, J. F. Geology of Moriah and Westport Townships, Essex Co. N. Y., with notes on the iron mines. 38p. 7pl. 2 maps. Sep. 1895. *10c.*

En11 (37) —— Catalogue of Some of the More Important Injurious and Beneficial Insects of New York State. 54p. il. Sep. 1900. *10c.*

En12 (46) —— Scale Insects of Importance and a List of the Species in New York State. 94p. il. 15pl. June 1901. *25c.*

En13 (47) Needham, J. G. & Betten, Cornelius. Aquatic Insects in the Adirondacks. 234p. il. 36pl. Sep. 1901. *45c.*

En14 (53) Felt, E. P. 17th Report of the State Entomologist 1901. 232p. il. 6pl. Aug. 1902. *30c.*

En15 (57) —— Elm Leaf Beetle in New York State. 46p. il. 8pl. Aug. 1902. *15c.*

This is a revision of En4 containing the more essential facts observed since that was prepared.

En16 (59) —— Grapevine Root Worm. 40p. 6pl. Dec. 1902. *15c.*

See En19.

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ENTOMOLOGY 20

MONOGRAPH OF THE GENUS SAPERDA

BY

EPHRAIM PORTER FELT D.Sc.
State Entomologist
and
LOUIS H. JOUTEL

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New York State Museum

FREDERICK J. H. MERRILL Director
EPHRAIM PORTER FELT State Entomologist

Bulletin 74

ENTOMOLOGY 20

MONOGRAPH OF THE GENUS SAPERDA

PREFACE

In the preparation of this paper all the original descriptions of the various species have been carefully examined, and as many of the types as were in this country have been studied. Most of our species are so well marked that there was little trouble in identifying them, and only tridentata and forms of populnea presented difficulties. The first mentioned has a species which resembles it very closely, and the question was, which had been described by Olivier. The original description was so vague that it applied equally well to either; but fortunately Olivier had figured the form described, and this proves beyond doubt that our common eastern borer of the elm is his species. Several forms, which could not be referred to any of our species, were found, one of which presented all the characters of the European populnea, and there is no doubt that it has long been established in California, Oregon, Washington and British Columbia, having evidently made its way into this country through Alaska.

The writers take great pleasure in acknowledging assistance from the following gentlemen: Dr Henry Skinner and Mr H. W. Wenzel, who employed their kind offices in procuring the loan of specimens from the collections of the American Entomological Society and afforded facilities for the study of material in the Horn collection, Mr Samuel Henshaw of the Museum of Comparative Zoology, who

granted the privilege of studying the LeConte and other collections at Cambridge, Dr H. G. Dyar, who procured the loan of material from the National Museum, Mr E. A. Schwarz, who furnished facilities and aid in studying the collections at Washington, and also the following gentlemen, who rendered various services, Messrs Charles Schaeffer, Frederick Blanchard, F. C. Bowditch, Germain Beaulieu, H. G. Klages, Charles W. Leng, C. V. Piper, W. S. Marshall, J. J. Rivers, Charles Fuchs, Dr D. M. Castle, E. D. Harris, Philip Laurent, F. E. Watson, C. W. Woodward, H. C. Fall, William T. Davis, C. J. S. Bethune, F. M. Webster, Charles Palm, W. Knaus, A. F. Winne, Dr R. E. Kunze, Charles Stevenson and C. J. Oeillet. Dr Henry C. Van Dyke kindly contributed notes on localities of hornii, and a number of New York collectors kindly allowed us the privilege of examining the material in their collections.

The junior author has collected members of this genus for a number of years and has made many trips about New York city to secure their workings, often in the company of his friend, William T. Davis, who took much interest in securing desirable specimens. All of the species have been bred but the typical populnea, mutica, hornii and cretata, though we have had workings of the latter.

The junior author has undertaken the illustration and systematic study of the species; while his associate has studied the insects more particularly from an economic standpoint and has summarized the literature and compiled the bibliographies.

GENUS SAPERDA OF FABRICIUS

This genus is one of great economic importance, since it contains two species which are very injurious to appletrees and another which may possibly acquire this habit. One species is known as being very destructive to the American elm, one often seriously injures hickory, another sometimes destroys large numbers of our lindens, and a fourth is exceedingly injurious to poplars; the latter are also attacked by several other species of the genus.

This group is also of interest to the systematic student, since it shows in a limited number of species great divergence and specialization from a common type. Much confusion has hitherto existed concerning the identity of our western species, and this was only partly

cleared up by the characterization of hornii. Our study has brought out the interesting fact that, among the so called western forms of moesta, one is identical with the European populnea, and can not be differentiated in any particular from that species. We find that two species have been included under the name tridentata, as well as a distinct variety of lateralis. All but three American species occur in New York State, and our study has on that account been monographic.

Series of all American species have been examined, and several characters not noted or seen by former students have been found. The European and Asiatic species have all been studied, except a few Siberian forms which are probably only varieties. Since both sexes were not obtainable of all the exotic forms, it has not been possible to include a discussion of them in this paper. They are mentioned wherever it is necessary to show the close relationship existing between the two faunas.[1] The 13 species and one variety listed by Samuel Henshaw in 1885 have been increased by us to 15 species and five subspecies or varieties.

The species are so closely related, though differing greatly from each other in several characters, that subdivision of the genus is not considered advisable and would not be practicable, as whatever characters might be used, disappear so gradually that the species could not be as well arranged as in the present grouping, and it would tend to bring widely separated forms close together.

The exotic species have been divided into a number of genera and subgenera on characters which we consider, from our studies of the entire group, degrees of specialization.

Mr Mulsant divided the European species on the relative size of the metathoracic episterna, the form of elytra and on the antennae

[1]In studying the two faunas together, the indications are very strong that they were derived from common ancestors; and, while the two are quite distinct in many ways, they have evidently specialized along different but parallel lines, and their characters are intermediate.

The fact that the American species are all of eastern origin (except those few that show their immigration into the Pacific fauna through Alaska) and the Old World ones of western origin would tend to show that at some remote epoch there was a connection between the two continents.

being annulated or not. Species not closely related to each other occur in his subgenera, as they do in any other attempt to divide them. His genera are not now generally recognized. The Asiatic species have been placed in several genera. The genus Thyestes erected by Mr J. Thomson for a Japanese species has no character not found in one or the other of our Saperdas; and we consider his species pubescens allied to puncticollis with some characters also of lateralis; and its annulated antennae connects it with the more highly specialized ones. Another point that shows its close relation to puncticollis is the possession of a process on the anterior claw of the middle pair of legs only; and the form of this process also resembles that of puncticollis. Another genus, Eutatrapha, has been erected by Bates for those Asiatic species with the sides of the elytra carinated. We consider this character a sign of specialization and not of generic value, as we find it in an advanced rudimentary state in our tridentata, where it is not equally marked in all specimens. It is formed by the arrangement of the punctures and is quite different in appearance from the extreme form found in Eutatrapha (Saperda) metallescens. Eutatrapha (Saperda) 16-punctata and varicornis (S. carinata) have this character also, but not so strongly marked. It can be traced in some other of our species, as S. discoidea ♂ and S. hornii, where a straight line of punctures, more or less pronounced in different examples, shows the most primitive form of this character; and its entire absence in some individuals of discoidea robs it of any generic value it seems to possess in its more highly specialized form. To show the slight value of this and other characters taken separately, we would call attention to Paraglenea fortunei from China, which has the elytra carinated and has both claws of all the legs armed with a spine as in lateralis. It is closer to Saperda than any other genus. Glenida suffusa has the elytra carinated but lacks the process on the claws, and is only distantly related to Saperda. Several other genera were desired for study but material was not obtained in time for this bulletin. The males of metallescens have

the claws armed as in tridentata. Males of the other carinated species were not obtained. Should this genus be accepted our S. tridentata would be included in it.

Subgeneric grouping. One character that could be used for a subgeneric division is the presence or absence of the process[1] on the claws of the males. Though we consider this character of little value except to show the relation of the species and really a sign of specialization and not of much generic importance, as its occurrence in genera[2] not very closely related to Saperda shows, its use as a basis of division would group the species as follows.

Group 1	Group 2	Group 3	Group 4
Process on anterior claw of front and middle tarsi	Process on both claws of all tarsi	Process on anterior claw of middle tarsi	Process wanting
obliqua mutica hornii candida calcarata tridentata cretata discoidea vestita imitans fayi	lateralis	puncticollis	populnea and its forms concolor

[1]LeConte and Horn, in their classification of the Coleoptera of North America, make the erroneous statement that this process is wanting in the European species. It is however very prominent in carcharias, punctata, 8-punctata and probably in others of which we did not see males. Lacordairé, in *Genera of Coleoptera,* also seems to imply that it is wanting in the European species. LeConte, in *New Species of North American Coleoptera,* part 2 [Smithsonian Miscel. Coll. 264. 1873. p.239] overlooks the process on the claw of the middle tarsi of puncticollis and the armature of all the claws of lateralis. Subsequent authors have committed the same errors.

[2]In the species of Thyestes which we have seen, the males are armed as in puncticollis. The males in the genus Eutatrapha are armed as in the first group. Those of Paraglenea fortunei are like those of lateralis. The males we have seen of the European species group as follows. To the first group belong carcharias, punctata, 8-punctata, and to group 4 populnea and scalaris. The males of the other species we were not able to obtain.

This grouping separates populnea and concolor from the closely allied mutica and hornii, and brings together some that are not so closely allied, but it shows fairly well the degree of specialization of the species, as will be shown later.

If our species only are considered, a more natural grouping can be made on antennal characters, the species having annulated antennae being more closely related to each other than to those with unicolorous ones; but, when the foreign species are taken into account, this character loses its value, as we find S. perforata and some of the species that have been referred to Eutatrapha and Thyestes with the antennae annulated, though the other characters would lead us to look for unicolorous ones, they being very close to our tridentata and but distantly related to the species this character would place them with. Using the antennae, the species would divide as follows.

Antennae annulated	Antennae unicolorous
obliqua	candida
mutica	calcarata
hornii	tridentata
populnea	cretata
moesta	discoidea
tulari	vestita
concolor	imitans
	fayi
	lateralis
	puncticollis

The foreign species, carcharias, scalaris, perforata, similis, quercus, Eut. varicornis, 10-punctata and T. pubescens would come in the first group; the others in the second group.

The development of the head usually follows that of the process on the claws; but there are exceptions to this rule, as is seen in the case of scalaris of Europe, where the flat front of the head would place it near calcarata instead of with populnea, where it more naturally belongs. In fact, whatever character is taken, it

will be found to be unevenly developed in its relation to the others possessed by the species.

Other characters such as elytral form, shape of thorax and abdomen, etc., seem from our studies to have little if any constant value in grouping the species, as, when they are used, species are brought together that have very little direct affinity with each other.

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Distribution. The genus is confined to the temperate parts of the northern hemisphere. The distribution of some of the species is somewhat erratic, and all but three American forms appear to have originated in the East and occur in the State of New York. Our common calcarata, found through the East and Middle West, also occurs in Texas as well as the state of Washington, and has been recorded from intervening territory. On the east coast tridentata has much the same range and is likewise found in Texas, but not in the northwest. Obliqua, candida, cretata, fayi, vestita, discoidea, lateralis,

punc ticollis and moesta have about the same range, being found in Canada, in the eastern states and also in the Middle West. The typical populnea is found only on the Pacific coast, tulari occurs in the same localities and also in Colorado and Arizona. Concolor is found in Arizona and Colorado. The variety unicolor has the same general range as moesta. Hornii is confined to the western coast from Los Angeles Cal. to British Columbia.

Specific relationships. Before attempting to group the species according to their natural affinities, a few remarks on their specific characters may be of interest. The antennae of most species are unicolorous. In some, obliqua, mutica, hornii, populnea, moesta, tulari and concolor and its variety, they are more or less annulated with gray, (brown and black in obliqua), and two of these species have the first joint enlarged. The length of the antennae also varies in the different species, being very short in mutica.

The shape of the last segment of the female abdomen presents an excellent character for the separation of some species. The pygidium of some is broad with the apex blunt and in others it is long. The tip may be more or less divided into two lobes, the upper surface may be either marked by a median depression or may be convex as in mutica.

The angle formed by the sides varies in different species. The front claws of the anterior and middle tarsi of the males are armed with either a blunt process or tooth, which is lacking on the front pair in puncticollis, wanting on all claws in populnea, moesta, tulari and concolor and present on both claws of each pair of legs in lateralis. This process is subject to variation as to size and form in individuals of the same species, and it has been used as a specific character as little as possible. The shape of the thorax, whether cylindric or narrowed in front, affords a good character. The form of the apex of the elytra is of value in determining species, as they may be rounded, obliquely narrowed, armed with a spine or truncate. The shape of the head

and eyes varies greatly in different species. The punctures of some species are quite constant; but in others, populnea, moesta, tulari, they vary so much that little dependence can be placed on them. The species range in size from calcarata, which is from ⅞ to 1⅛ inch long, to populnea ⅜ inch in length, but occasional specimens may be much smaller than the normal. The color and markings are quite constant, and only lateralis shows marked variations. Calcarata has a variety, adspersa, which is entirely brown. The legs of most species are black, covered with a gray pubescence, yellow in vestita; those of obliqua, cretata and discoidea are reddish brown with gray pubescence.

Arrangement indicates the degree of specialization. The salient characters of the various species having been given, it now remains to use them in a natural grouping of the forms. It is very apparent that the usual arrangement is arbitrary and based almost entirely on color and markings. It is not to be supposed that the following grouping means that the species are derived or descended from each other. It represents simply our idea of the degree of removal or specialization from an ancestral type and is based on a study of characters of unequal value. It is very evident that our own species have specialized along different lines and have probably originated from several type forms.

The least specialized of our native species is evidently concolor, since it is unicolorous, has no striking characters and presents fewer differences from its nearest allies in other genera, than any of the other species. It has no process on the claws of the male and the rather few elytral punctures are merely shallow depressions without definite edge and are punctate like the remainder of the elytra. The species diverging most widely from it, and therefore the most specialized, is obliqua, since it has characters not possessed by any of the others. It has the elytra separately narrowed and armed with a spine. The thorax is narrowed in front, and the head is small, and deeply impressed between the eyes. The annulated antennae have the first joint swollen and dark, and the elytra are embossed to match the color pattern. The process is very highly

specialized as can be seen by reference to figure 3. The species which possesses the greatest number of these characters is mutica. It is true that it lacks the spine at the apex of the elytra, but it has the narrowed thorax, small head and the antennae with an enlarged, dark basal joint. These two species form a group by themselves closely approached by hornii (which is nearly related to the European similis); it has the annulated antennae, but the first joint is normal and the thorax is nearly cylindric, in some specimens entirely so. The color and maculation are much like those of mutica. We then come to the European carcharias, with its narrowed thorax and annulated antennae. The humeral angles are quite prominent and the elytra tapering. The nearest American representative is candida, an insect which at first would not seem to belong here, but that is due more to the color and markings, characters of the smallest value, since, if we omit the color from consideration, we shall find that the shape and structure are very similar to carcharias, as represented by the narrowed thorax, small head, prominent humeral angles and tapering elytra. The unicolorous antennae show candida to be less specialized than this European species. Calcarata, our next species, is also somewhat related to carcharias and leads naturally to tridentata, which is of the same general shape and has in addition the elytra truncate and weakly sinuate at tip, evidently an early stage of the sutural spine found in calcarata. Tridentata has a character (a submarginal carina beginning at the humeral angle and continuing to the apex) not present in any other of our forms, but which, strange to say, has its counterpart in some old world species.[1]

The remaining species appear to follow in regular order as given in Henshaw's list, except that fayi would more naturally follow lateralis, since it has the rounded head possessed by the species that follow and the same gall-making habit. The spine on its front claws is very small and rudimentary, approaching the condition of

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[1]This character is made use of by Bates to form the genus Eutatrapha, to which he refers 16-punctata, varicornis and metallescens. It would also include tridentata. [*See* p. 6]

punc ticollis, where it is entirely absent. Imitans is close to lateralis and fayi and presents more characters in common with the last than with tridentata, though its markings are much like the latter.

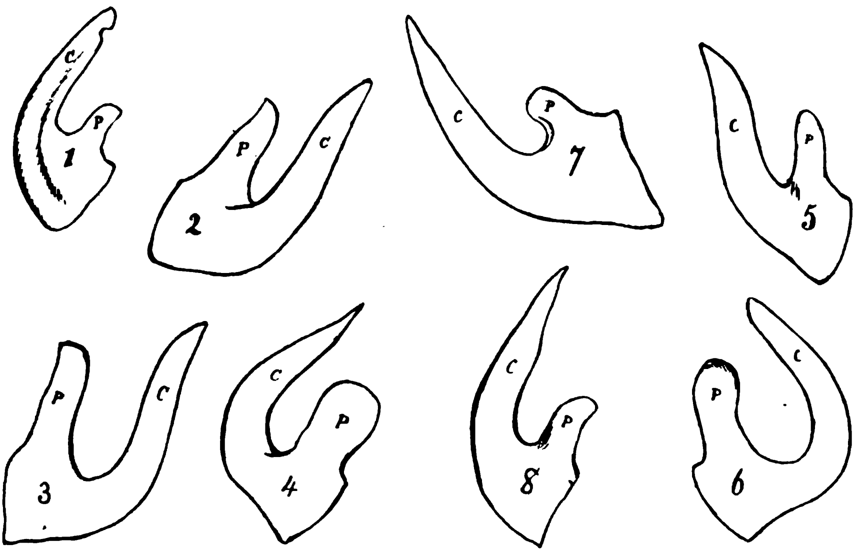

Fig. 1 Front claw of first and middle tarsi of the following species: 1 and 2, Saperda imitans; 3 and 4, Saperda tridentata; 5 and 6, Saperda discoidea; 7 and 8, Saperda vestita. C= claw, P= process.

Systematic list of American species of Saperda

obliqua *Say*
mutica *Say*
hornii *Joutel*
candida *Fabr.*
calcarata *Say*
  var. adspersa *Lec.*
tridentata *Oliv.*
cretata *Newm.*
discoidea *Fabr.*
vestita *Say*
imitans *n. sp.*
lateralis *Fabr.*
  var. connecta *n. var.*
fayi *Bland.*
puncticollis *Say*
populnea *Linn.*
subsp. moesta *Lec.*
subsp. tulari *n. subsp.*
concolor *Lec.*
  var. unicolor *n. var.*

The development of the process on the claws follows the foregoing arrangement better than any other, and we find that the degree of development is somewhat different from published accounts of earlier workers, who probably lacked sufficient material.

Process moderate on anterior claw of front and middle tarsi: obliqua, mutica, hornii, candida.

Process long on anterior claw of front and middle tarsi: calcarata, tridentata, cretata.

Fig. 2 Front claw of first and middle tarsi of the following species: 9 and 10 Saperda cretata; 11 and 12 S. candida; 13 and 14 S. hornii; 15 and 16 S. calcarata. C= claw, P=process.

Process shorter on anterior claw of front than middle tarsi: discoidea, vestita, imitans.

Process small on both claws of all tarsi: lateralis.

[1] Process very small on anterior claw of front and small on middle tarsi: fayi.

Process wanting on front and large on middle tarsi: puncticollis.

Process wanting: populnea, moesta, tulari and concolor.

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[1]As this process shows considerable variation in shape and size in different specimens of the same species, we have taken the most common shape and size as the normal for each species.

Key to species

a Antennae plainly annulate
 b Head deeply impressed between the eyes
  c Antennae with first joint normal and gray.............. hornii
  cc Antennae with first joint enlarged and dark
   d Elytra obliquely narrowed, ending in a spine at the tip .... obliqua
   dd Elytra slightly narrowed and without a spine........ mutica

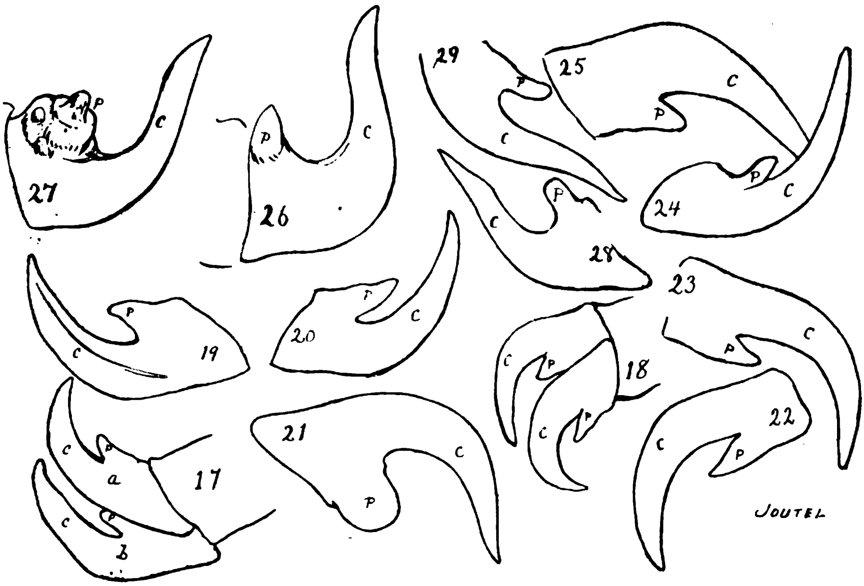

Fig. 3 Claws of following species: 17 Both claws of front tarsi of S. lateralis; 18 Both claws of middle tarsi of S. lateralis; 19 Front claw; 20 Posterior claw of middle tarsi of S. lateralis; 21 claw of middle tarsi of S. puncticollis; 22 and 23 Claws of hind tarsi of S. lateralis; 24 and 25 Claws of front and middle tarsi of S. fayi; 26 and 27 Claw of front and middle tarsi of S. obliqua; 28 and 29 Claw of front and middle tarsi of S. mutica.

 bb Head rounded in front
  c Antennae with first joint black and normal in size
   d Upper side strongly punctate and confluent with few punctulations between, sparsely covered with gray or light fulvous hairs, several spots of dense yellow or fulvous hair on elytra; fulvous stripe on side of thorax........................populnea
   dd Upper side with punctures not so numerous, and sparsely covered with gray hairs, unicolorous, punctulations on intervals more numerous; light stripe on thorax nearly obsolete ....subsp. moesta
   ddd Upper side with fewer but larger and deeper punctures, more densely punctulate on the intervals and densely covered with red or fulvous hairs; thorax with stripe on sides and top ....subsp. tulari

dddd Upper side finely punctulate and with small shallow punctures and uniformly covered with a dense layer of light gray or yellowish gray hairs; thorax with lateral stripe
concolor

e Punctures much more numerous, hair dirty gray; lateral stripe wanting or nearly so....................var. unicolor

aa Antennae unicolorous

b Elytra rounded with spine at suture

c Gray with yellow patches...........................calcarata

cc Color uniform fulvous........................var. adspersa

bb Elytra with marginal or submarginal stripe

c Thorax and elytra brown or yellowish brown with two white stripes; under side white...........................candida

cc Thorax yellow with four black spots on dorsum and one on each side; elytra bordered with bright yellow with a black spot in front; under side gray......................puncticollis

ccc Thorax and elytra gray and with an orange red lateral stripe

d Second and third cross bands on elytra oblique, a dark spot usually on each side of the first and one behind the third; front of head very flat; elytra more or less truncate
tridentata

dd First and second cross bands on elytra oblique; front of head flat; elytra rounded at apex.....................imitans

cccc Thorax and elytra black

d Sutural and lateral stripe on elytra orange red; head somewhat rounded; under side gray.......................lateralis

dd Sutural stripe usually wanting and with one to three cross bands; lateral band reaching to margin; under side gray
var. connecta

bbb Elytra with spots, rarely concolorous

c Cinnamon brown with a white stripe on each side of the thorax

d A large white spot in center of each elytron and a smaller one near its apex, neither reaching to margins; sides and under surface white ....cretata

dd White stripe on thorax continuing on elytra at humeral angles; the elytra with two white spots, one at the middle, the other near the apex and almost sutural; sides and under surface white; the spots are more or less obsolete in the male..fayi

cc Cinnamon brown, sometimes nearly black, with a transverse, undulate, yellowish olive fascia across the middle of the elytra; sometimes with an additional spot both before and behind this fascia; thorax and apex of elytra and scutellum olive; legs light reddish, under side lighter...................discoidea ♀

ccc Uniformly reddish brown, sometimes black; legs reddish; under side lighter.................................discoidea ♂

cccc Olive yellow with three denuded black spots on each elytron, some or all occasionally wanting.................vestita

Grouping and summary of the food habits of the larvae

The larvae of this genus may be divided by their food habits into three classes: (1) those that bore in the large branches and trunks of living trees and feed on the sap, calcarata, candida, cretata, vestita and possibly hornii and mutica; (2) those that live in small branches and usually produce galls, subsisting on sap, and not making the extended galleries of the first group, fayi, populnea, obliqua, concolor; (3) those that feed on living and dead tissues of dying or recently killed trees, tridentata, discoidea, lateralis, imitans and puncticollis. The manner of feeding and the portion of the tree attacked vary with different species, and most of the forms have special food plants.

S. obliqua feeds close to the ground at the collar of the black alder, where it often entirely girdles the stem, forming a knot or gall and ultimately killing it; and, when not entirely girdled, the tree is so weakened that the stem soon breaks. A walk through an alder swamp where this insect is common will show a great number of prostrate stems in all stages of decay.

S. mutica. This species is said to live on the willow and is the only eastern form that we have not bred and of which we have been unable to secure workings.

S. hornii feeds on the willow according to Dr H. C. Van Dyke, who has taken the insect on that plant.

S. candida is usually very common in apple and attacks several allied trees. It is quite destructive to seedlings and young trees, where it works at the base of the trunk and roots, and, as several generations follow in the same wound, the tree is soon killed.

S. calcarata works in the trunk and larger branches of the silver poplar in particular and soon kills the trees. It is surprising to see the quantity of sawdust around a badly infested tree, thrown out by the larvae when making their pupal chambers.

S. tridentata works in and under the bark of the trunk and branches of the elm, and has also been recorded in other trees.

S. cretata lives in the thorn and apple, usually in the trunk and larger branches, and works somewhat like S. calcarata, but the burrow is longer and more tortuous.

S. vestita attacks the linden and in our experience works mostly at the base and roots. We have never found it more than 12 inches from the ground, and that seldom. It can always be found in exposed roots and at the base of the tree close to the ground. In either case the larvae usually work in the subterranean parts. Prof. F. M. Webster has also noted this habit.

S. discoidea lives under and in the bark of hickory, specially dying trees or those recently killed by Scolytus quadrispinosus Say. It can be easily bred from a piece of dead bark.

S. imitans is not known in its early stages but probably bores in hickory and not in elm.

S. lateralis works in hickory at some injured place near the root and is partial to the base of sprouts that grow around stumps on recently cleared land.

S. fayi makes a gall very simlar to that of concolor, but breeds in the thorn.

S. puncticollis works in the dead branches of Virginia creeper, eating the inner bark and pupating in a chamber excavated in the wood.

S. populnea feeds on the willow and poplar. S. moesta makes a gall on the balm of gilead, and this, we believe, is its only food plant, and the form tulari lives in willow.

S. concolor makes a gall on poplar and willow shoots.

Saperda obliqua Say

Alder borer

This species, while rarely met with in the adult form, appears to be very common in New York State, judging from the condition of some of the alder swamps we have visited.

Life history and habits. This insect's method of working is quite characteristic [pl. 5, fig. 3], and the badly girdled stems with gall-like enlargements, are not difficult to find. The insect works close to the ground in black alder, frequently girdling the trunks, and in infested swamps large numbers of prostrate stems in all stages of decay may be found. There are usually two or three

borers in each trunk, one of which is very apt to work downward to the depth of 3 or 4 inches and often below the ground level and the others in an opposite direction. The young grubs bore just beneath the bark, much like those of S. candida Fabr., and the nearly full grown individuals work near the center of the stems and not infrequently fairly riddle the base, causing it to break in the wind. In fact, the general method of work is very similar to that of the round-headed appletree borer, and the perfect insect emerges from a hole very similar to that made by the species infesting the apple.

The beetle [pl. 5, fig. 6] is generally found near the top of alder branches. Mr Fred Knab, of Chicopee Mass. states that it easily escapes notice on account of its great resemblance to a withered leaflet. He adds that it differs from others of its genus, which are also shy insects, in that it remains perfectly motionless, clinging tightly to the branch and with the antennae extended forward. He has also found this insect on birch. Dr Packard records the beetle as occurring on alder; Dr Smith states that it is rare throughout New Jersey, where it breeds in black alder; and the late Dr Lugger records it as breeding in hazel shoots.

Distribution. This species was described by Say from Missouri; it has been collected about Buffalo by Zesch-Reinecke; Dr Smith records it from New Jersey; and Dr LeConte from Pennsylvania. The following localities for this species have been given by Messrs Leng and Hamilton: Wisconsin, Mississippi, Canada, Massachusetts, New York, New Jersey, Pennsylvania and Missouri. It has been found in various localities about New York city, such as Bronx park, Fort Lee and Staten Island and has also been recorded from Alabama and Montreal. We have seen specimens taken in Illinois in the Bolter collection.

Description. Light reddish brown with darker bands; antennae annulate, with the first joint dark and swollen; thorax narrowed in front; a dorsal stripe of darker brown continuing on the head; a subdorsal stripe that converges and continues on

the elytra around the scutellum; a lateral stripe that connects at the humeral angle with the first of four oblique bands on the elytra. The spaces occupied by the darker portions are depressed and less pilose. The elytra are separately narrowed at the apex and armed with a spine. The head is strongly impressed between the eyes. The work of the larvae is well represented on the plate.

Natural enemies. No literature on this subject exists; but we have found a number of affected alders which showed the work of woodpeckers, and evidently these valuable birds are very efficient factors in reducing the numbers of the borers. In one short limb we found four good sized holes made by the birds in their search for grubs [pl. 14]. We have also found many of the larvae destroyed by a dipterous parasite which pupated in the burrows after destroying the maker; several larvae or pupae of this Tachinid are usually found in each working.

Another small dipterous larva is sometimes found in considerable numbers feeding on the larva or pupa but we have not been able to rear it.

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Saperda mutica Say

Life history. Very little is recorded concerning the life history of this species. Beetles were taken by Mr W. H. Harrington on May 15 and captured by him in the open on June 29. He records this species as living on decaying willow.

Distribution. This beetle has been recorded from the following localities: Missouri [Say], Buffalo [Zesch-Reinecke], New Jersey [Smith], Ottawa Can. [Harrington], Canada, New York, New Jersey, Missouri, Kansas and Nebraska [Leng-Hamilton], Philadelphia Pa. [Wenzel]. Dr LeConte thought that this species was probably the S. p o p u l n e a of Fabricius and Olivier. Its work is unknown to us.

Description. Black, sparsely covered with a gray or fulvous vestiture which is denser in places, forming numerous spots on the elytra [pl. 7, fig. 2]. These denser places are usually yellower in color. Antennae short, annulate, with first joint enlarged. Thorax narrowed in front with a fulvous line on dorsum, continuing on the head, also lateral line on sides. Head impressed in front between the eyes.

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1902 **Joutel, L. H.** Ent. News, 13:33-34 (S a p e r d a h o r n i i, compared with)

Saperda hornii Joutel

This species [pl. 7, fig. 3] has been mistaken for S. mutica, but can be easily separated from it by the first joint of the antennae being normal in size and also by the fact that the last abdominal segment of the female has a deep longitudinal impression along the middle of the upper side, while mutica has that part convex. The punctures of this insect are also much larger and deeper, and fewer in number.

Some specimens have lost the yellow marks and are entirely gray.

Distribution. Oregon, Los Angeles Cal.,[1] Humboldt county, Cal., Nevada county, Cal., Yosemite Cal., Goldendale Wash.

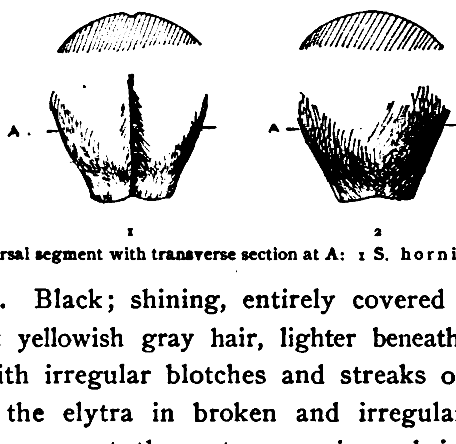

Fig. 4 Last dorsal segment with transverse section at A: 1 S. hornii; 2 S. mutica

Description. Black; shining, entirely covered with a dense layer of light yellowish gray hair, lighter beneath, and diversified above with irregular blotches and streaks of dark yellow arranged on the elytra in broken and irregular longitudinal lines, the line nearest the outer margin and just below the humeral angle unbroken except by the punctures, and continuing nearly to the tip. Elytra obliquely narrowed at apex. Thorax cylindric, sometimes slightly narrowed in front, with a longitudinal stripe of dark yellow hair on each side and on top, under side yellow. Scutellum yellow. Entire insect covered by rather large and deep punctures, slightly smaller beneath. Head: hairs yellow, changing to gray at labrum. Legs and under side of body light yellowish gray with glabrous punctures. Antennae annulate except first joint, which is entirely gray and

[1]In the original description, the locality of the type male in the national museum was wrongly given as Yosemite Cal. It should be Los Angeles Cal.

moderate in thickness. The pygidium of the female has a deep longitudinal depression along the median line, dividing it into two lobes.

Its work is unknown. Mr J. J. Rivers and Dr H. C. Van Dyke have both taken it from willow.

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1902 **Joutel, L. H.** Ent. News, 13:33-34 (Original description)

Saperda candida Fabr.

Round-headed appletree borer

There is perhaps no better known enemy of appletrees than the above named insect. The common designation, apple borer, usually refers to this insect, though by common consent it is gradually becoming known as the round-headed appletree borer in contradistinction to the destructive flat-headed species, Chrysobothris femorata Fabr., which is frequently very abundant in appletrees. The round-headed appletree borer is particularly injurious to young trees, and it is probably responsible for the death of more of these than all other natural agents combined.

Early history. This species was very early known as a notorious pest throughout New England and the Middle states according to Dr Harris. Mr Philip Heartt of Troy lost in 1825 several hundred young appletrees which he valued at $2000, many of them being so seriously affected that the base of their trunks was literally honeycombed by the galleries. The late Dr Asa Fitch stated that, of $10,000 worth of trees sold in Washington county in 1851, fully one half were destroyed within eight years. Not infrequently the borers were so abundant as entirely to girdle the tree. Mr William Couper, in 1862, attributed the great destruction of appletrees about Quebec to the ravages of this insect. Mr D. B. Wier, of Wisconsin, writing of this species in 1872, characterizes it as one of the worst enemies of fruit trees and states as his opinion, that it would destroy 5000 out of 10,000 young trees within three years. Dr

J. B. Smith considers this borer very destructive to young apple-trees in many parts of New Jersey and states that it is a more serious enemy of the quince. Miss Mary Treat, of Vineland N. J., writing of this insect in 1893, stated that it was unusually abundant in that section and threatened to kill the trees in spite of all efforts, 10 to 12 borers being found in one. Mr G. T. Powell, of Ghent N. Y., reports taking 30 grubs from a tree in 1889, a year when they were unusually abundant.

The work of this insect is so insidious that it is difficult to gain an adequate idea of its great destructiveness, specially as the sickly condition of the trees is frequently attributed to some other than the true cause.

The above brief records will give some idea of how dangerous an enemy this beetle is; and it is very likely that in future years appletrees will have to be guarded more closely than in the past, if they are to be protected from serious injuries by this pest.

Life history. The adult beetles have been observed abroad during June, July and August. Dr Fitch states that the beetles begin to appear in Washington county, N. Y., about June 20. They are secretive in habit and deposit eggs in the bark near the ground. Mr Zimmerman records the appearance of the beetle June 2 and 3, 1878, and adds that this date is 20 days earlier than usual. Prof. Cyrus Thomas, writing of this pest in 1877, states that it appeared in May in Illinois, and Mr D. B. Wier, of Wisconsin, gives the date of the appearance of the beetles from the middle of May to the middle of June. Mr Tallman has recorded finding this species in copulation on elm June 7. Dr J. B. Smith, state entomologist of New Jersey, gives the date of the occurrence of the beetles from May 20 to July 15.

The egg of this borer is a pale, rust-brown color, about ⅛ inch long, one third as broad in the middle and somewhat flattened, so that its depth is about one third its width. It is rather easy to find eggshells in the oviposition scars [pl. 1, fig. 2], and it will be seen that they are fairly tough, without any sculpture and sufficiently plastic to receive impressions of wood fibers between which they may be placed.

The oviposition scars [pl. 1, fig. 2; pl. 8, fig. 1] may be readily detected as longitudinal slits in the bark, ranging from ¼ to as much as ¾ inch in length. These scars have somewhat irregular, dried edges, and in early spring usually have small, rust-red borings hanging therefrom [pl. 8, fig. 2]. Their location is made more apparent by the adjacent discoloration and shrinking of the areas where the young grubs are at work in the underlying green tissues [pl. 8, fig. 3]. These scars are sometimes very abundant on young trees. The writer observed 11 of them on a portion of a smooth trunk less than 6 inches long and 1½ inches in diameter [pl. 8], and all were within 6 inches of the ground, two being close to its surface. The importance of these marks lies in the fact that they indicate the location of the young grubs, which may be reached and destroyed in the fall or early spring without material injury to the tree. The splitting of the bark is primarily caused by the female in preparing for deposition of her eggs, and the orifice is further enlarged by the consequent shrinkage and drying following the operations of the grub. On cutting into one of these scars [pl. 8, fig. 3] in early spring, young grubs, ranging in size from ⅛ to ¼ inch in length, may be found in the shallow cavity in the inner bark and outer sapwood, and in some cases remains of the eggshell may be observed. The method of oviposition has been described by Dr C. V. Riley as follows:

The female beetle makes an incision in the bark, causing it to be split from ⅙ to sometimes ½ an inch. The incision is often made entirely through the bark, and the egg is thrust between the bark and the liber at right angles to one side of the slip, from ⅛ to ¼ of an inch from the aperture. Sometimes the bark is but partially penetrated, in which case it is pried open on one side of the aperture for the reception of the egg. In either case the egg is accompanied by a gummy fluid which covers and secures it in place and usually fills up the aperture. In young trees, with tender bark, the egg is usually thoroughly hidden; while in older trees it is sometimes so shallowly embedded as to be readily seen.

Mr W. Junkins, in the *New England Homestead* of Jan. 3, 1885, has also described this interesting process, as it occurs on twigs set in moist sand in a jar: June 15 he observed one of four females

deposit an egg. "She first made an incision in the bark close to the sand; then, turning her head upward, with her ovipositor she placed the egg in the bark nearly ¼ of an inch from the incision, the bark having been started from the wood."

Mr D. B. Wier states that the beetles copulate from 10 days to two weeks after reaching maturity, and soon after the females commence to lay eggs. They are mostly deposited by night, usually from 1 to 10 inches from the ground. He observed that, where the beetles are numerous, several females will often lay their eggs on the same tree at different times, sometimes as long as two or more months apart. He has found as many as 27 young borers of eight different sizes in one tree in September. The eggs are said by Professor Chambers to hatch in about 14 days, and Professor McMillan gives the time as 18 days. The period observed by Mr Junkins, June 15 to July 7, was 22 days. Mr Buckminster believed that the females lay about 10 eggs, which hatch in about eight days, as stated by Gay. Dr Saunders, in his *Insects Injurious to Fruit*, states that the beetle bores into the bark and deposits an egg in the cavity thus made; and Dr Dimmock, writing of this species in the *Standard Natural History*, observes that the cavity is filled with a cementlike secretion.

The young borer, or larva, almost invariably works downward just under the bark, making a somewhat sinuous channel with an oval enlargement at a variable distance from the point where the egg was laid. This oval chamber is evidently where the winter is passed. The presence of the insect is readily detected later, or in spring, by the rust-red borings which are ejected or forced out of the galleries [pl. 1, fig. 3]. There has been some discussion as to whether the larva actually ejects the borings. Dr Fitch was of the opinion that they commonly had the aspect of not having been forced out by the worm but of being thus crowded out because the mass under the bark swelled when dampened by rain soaking through the dead tissues and saturating the contents of the galleries. This explanation did not satisfy us. Our observations have been that the older larvae of this species always have more or less clear gallery space to travel about in and this they keep clear for the time being. They connect the interior workings with the chambers under the bark where they

fed on the sap. When gnawing in the interior galleries they throw the debris behind and void their excrement from time to time while working; when tired or with hunger satisfied they take this frass in their mandibles and pack it in the galleries and corners of the "bark" chamber out of the way occasionally removing and repacking in some other place. They will also carry it to openings in the bark of their feeding chambers, and push it out, using the mandibles only. When at work in the "bark" chamber they void their excrement through one of the openings, ejecting it so that it will fall outside. This is usually done when the voided matter is soft and watery.

The life history of this insect may be summarized as follows: The young borer, on the approach of winter, descends as near the ground as its burrow will allow and remains inactive till the following spring, when it begins operations anew, and on the approach of the second winter it is about half grown and still living in the sapwood. It is at this period that the most damage is done, for, where four or five occur in a single tree, they almost girdle it. The next summer, when it has become about three fourths grown, it cuts a cylindric passage upward into the solid wood and, having finished its larval growth, continues this passage to the bark, sometimes cutting entirely through a tree to the opposite side and sometimes turning back at a different angle. Several borers in one tree will fairly riddle its base [pl. 9]. The upper end of the passage is stuffed with fine borings and the lower part with long wood fibers [pl. 1, fig. 5, 6]. After this the larva remains unchanged through the winter, transforming to a pupa the following spring, and the beetle appears some time during the summer, leaving through a circular exit hole [pl. 1, fig. 7; pl. 9]. The latter frequently becomes overgrown, as represented in plate 8, figure 4.

Habitat. This species is said by Dr LeConte to occur in the Middle, Western and Eastern states. Professor Cook states that it is widely distributed in Michigan, and Rev. C. J. S. Bethune, writing of the insect in 1877, records it as very abundant in the Niagara district and in the vicinity of Montreal and Quebec. Professor McMillan stated in 1888 that every orchard in Nebraska was infested.

It has been recorded specifically by various writers, from Canada, all of New England, Delaware, Maryland, Michigan, New York, New Jersey, Pennsylvania, Ohio, Missouri, Iowa, Kansas, Texas, Alabama, Mississippi, Oklahoma, Virginia, Arkansas, West Virginia, District of Columbia, and Mount Desert Me. [Harris].

Food plants. This pernicious borer is apparently limited to relatively few food plants. It is specially injurious to the quince and nearly as much so to the apple. Its native food plants are the thorn, mountain ash, chokeberry (Pyrus arbutifolia) and shad bush. It has been recorded by Walsh as rare on pear and by Beutenmuller as attacking plum and cherry.

Description. Brown above with two white bands joined at the front and extending to the apex of elytra, under side and front of head white. Antennae light gray, legs lighter gray [pl. 1, fig. 1].

Natural enemies. Not very many enemies of this insect have been discovered. An undetermined carabid larva was found preying on the borers by Walsh and Riley in 1866. Promachus saperdae Riley M. S., now known as Cenocoelius populator Say, was bred from borers received from Indiana by Messrs Riley and Howard in 1890. The downy woodpecker and the great golden woodpecker have been seen in infested orchards by Miss Mary Treat of Vineland N. J. but none of them were observed at work around the base of the trees. Dr Fitch in his first report states that the downy woodpecker, which is frequently seen in the orchards, is one of the means provided by nature for keeping this insect in check, and adds that a neighbor, who had devoted much attention to birds and their habits, informed him that he had repeatedly noticed this woodpecker remaining for a considerable time down at the very root of appletrees, busily occupied in some operation. This would seem to be very good evidence that this bird does prey on this borer. That woodpeckers do this is conclusively proved by specimens recently collected in the vicinity of Albany, which show the characteristic work of these birds, but unfortunately give no clue to the identity of the operator.

Preventive and remedial measures. The control of an insect pest of this character may be brought about in two ways: (1) the

insect may be prevented from infesting the tree in some manner, or (2) destroyed after it has obtained entrance.

Dr Fitch had his attention called to the beneficial effect of soap applications, and he states that, if the bark of the trees be rubbed with soap the latter part of May, no borers will attack them. This was tested by him with the result that treated trees were free from the pest, while almost all of the untreated ones were infested with borers. One of the latter, only 3½ inches in diameter, contained 15 of the grubs. Mr Fowler has proposed the use of 2 quarts of whale oil soap and ¼ pound of sulfur and enough clay to give the mixture the consistency of paint, and advises applying the compound early enough to prevent the deposition of eggs. Professor Cook in 1881 thought washing the trunks and larger branches of the trees in May and the last week in June with soap would protect them from the borers, and Prof. C. M. Weed has advised the use of what we know as the carbolic soap wash and observes that it is very effective when thoroughly applied. Some observers, however, state that soap applications, and similar preventive measures, are of comparatively little value, and a few consider the alkaline washes more effective than soap. A band of tarred paper, or bands of newspaper, wrapped tightly around the base of young trees during the period the beetles are abroad, affords considerable protection and is used rather extensively in some fruit-growing sections. The bands should extend from the soil about 2 feet high, should be tied at the top so that the beetles can not get behind the band and should make a fairly tight connection with the ground. Professor Slingerland has recently advised trying a coating of coal tar, first testing to see if the trees were injured by this substance. Whitewashing the trunk has also been advised by certain writers and appears to have a somewhat deterrent effect. The application is comparatively inexpensive and, in absence of anything else, may well be employed. Dr J. B. Smith has advised the use of a poisoned whitewash. The use of ashes about the roots is also good, since, if they are heaped somewhat, they will protect the lower portions

of the tree from injury. The idea of these applications is to coat the bark or protect the base of the tree with some substance which will deter the beetles from depositing their eggs and therefore prevent infestation. These applications should be made in this latitude by the latter part of May and again early in June, or, in the case of permanent bands, the application of them at the earlier date is sufficient. Dr Fitch states that, in his observation, the worst infested trees are shaded and choked by suckers, and he therefore urges keeping the base of the trees clean. It is undoubtedly a good practice to observe this advice, since it at least permits the ready detection of the borers. We believe that suckers at the base of the tree are frequently caused by serious injuries by the larvae, and our experience indicates that a tree with an unprotected trunk is almost as likely to be attacked by the insect as one with its base shaded.

Thomas Say in 1825 recommended covering infested trees the latter part of April or early in May with mortar in order to prevent the emergence of the borers. This, so far as we can learn, has never been extensively tried and is of doubtful value. After the insect has once made its way into the tree, there is nothing better than cutting out the borers and destroying them, or killing them with a wire while in the tree. Either operation is best carried out in September or October or in early spring, because the work of the young borers is apparent at this time, and the recent borings facilitate their detection. A young tree will recover if the bark be extensively cut with a knife, and the over-cautious operator should remember that the borer is very likely to cause more injury if allowed to remain. The use of the wire will undoubtedly avoid considerable cutting in some instances, and it should be employed wherever practicable. Dr Fitch has advised cutting into the upper part of the boring, removing the sawdust and then killing the pest by pouring in a considerable quantity of hot water. This is undoubtedly efficient; but it appears to have a limited application, and in most cases it is probable that cutting out or destroying with a wire is to be preferred.

The quince suffers most from this borer, and perhaps the best method of controlling the pest in quincetrees is that described

by Mr Woodbridge Strong in the issue of the *Country Gentleman* for Mar. 20, 1890. His plan consists in providing the quince with a trunk which is practically borer-proof, and he accomplishes this by first taking stocks of English hawthorn and grafting on them varieties of Crataegus crus-galli or coccinia, which are worked on the hawthorn at the surface of the ground, and a year later hawthorn is worked back onto the native stock about a foot above and then quince on that a few inches higher. This compound tree is then set so that the hawthorn stock is below the surface of the ground and the Crataegus occupies the first foot. Mr Strong states that such trees make very satisfactory growth and fruit readily, and that, while the work of preparing them is difficult and involves considerable labor, the results amply justify the expense.

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Saperda calcarata Say

Poplar borer

This is the largest of our native species and is equaled in size only by the European S. c a r c h a r i a s. This species is of considerable economic importance on account of its serious injury to the trunks and larger branches of poplars. These trees rarely attain any size in New York State before showing the operations of this insect, and in not a few instances very serious injury is inflicted. This applies not only to neglected trees along road sides and in forests but also to magnificent specimens grown for ornamental purposes in parks. In Washington park, Albany, this species has recently caused a great deal of damage, breeding in large numbers in a group of magnificent white poplars. We have also observed similar injury in New York city and Brooklyn.

Early history. Dr Harris, in his classic report, *Insects Injurious to Vegetation,* states that this species in conjunction with the broad-necked Prionus, Prionus laticollis, nearly destroyed the lombardy poplars in the vicinity of Cambridge Mass. in the early 40's. In 1880 Mr Shelby Reed, of Scottsville N. Y., lost two fine trees on a lawn through the depredations of this pest. Dr Packard reports it as very injurious to poplars along the shores of Casco bay, Me., in 1884, and in 1892 it had caused great depredations among the silver poplars of Cincinnati O. according to Charles Dury. Professor Riley, in his early writings, states that this insect has been universally destructive to cottonwoods and poplars in the western states, and Professor Bruner, in his paper, "The Insect Enemies of Ornamental and Shade Trees," states that this borer is by far the most destructive enemy of poplars and cottonwoods in the west. He further adds that it is almost impossible to grow these trees of any size in cities and towns of Nebraska away from the friendly care of birds and parasitic insects.

Life history. The recorded life history of this insect is very meager indeed. Dr Harris states that the beetles [pl. 2, fig. 1] occur on the trunks and branches of various forms of poplar in August and September, and other writers notice the life history of the insect in a very brief manner.

The most obvious signs of infestation are the numerous blackened, swollen scars along the surface of the trunk and limbs. Sometimes these are open, and in early summer large quantities of borings are expelled from the inhabited galleries, and frequently occur in considerable piles about the base of the trees. This is very evident during the latter part of May and in early June. Our observations show that pupae [pl. 2, fig. 2] may be found in considerable numbers in early June in the vicinity of Albany, and that adults appear in early July and continue to emerge throughout that month and probably also during August and into September. In early June we have found full grown larvae [pl. 2, fig. 3] which apparently were nearly ready to pupate, and many pupae, though no beetles breed therefrom

till into July. This would therefore prove that the pupal stage lasts three or four weeks as a general rule. The pupal chamber [pl. 2, fig. 2] is invariably near the center of the smaller limbs and at some distance from the surface in trunks. The top is smoothly cut, and the other end is closely packed with coarse fibers which are attached to the side of the gallery at one end, and the portion next the pupa is packed with much finer borings and then coated with very fine sawdust. This pupal chamber appears to be made the previous season, but transformation to the pupa does not occur, as in other species, till spring. There are no records regarding oviposition habits, but this species, like S. candida, makes a small slit in the bark and deposits its eggs just underneath the surface. The young larva [pl. 10] works in the inner bark and the outer sapwood for a short time and before the approach of cold weather sinks its burrow to a greater depth. The borings of the second year are confined very largely to the interior of the wood, and during this stage the limb or trunk may be honeycombed by very large, somewhat irregular galleries. In the latter stages of their existence, the larvae not infrequently excavate broad shallow galleries in the sapwood and inner bark and appear to subsist to a considerable extent on the sap collected in such cavities. This insect probably requires three years to complete its transformations.

Food plants. This borer has been recorded as destructive to lombardy poplar [Emmons], cottonwood [Walsh], Populus tremuloides, the common aspen [Jack], cottonwood, poplars and willows [Lugger], is not rare on diseased Populus [Hamilton], on cottonwood and other poplars [Adams], very common [Provancher].

Description. Covered with gray hairs, diversified with patches of yellow hairs on the elytra, which latter end in a sutural spine. Thorax with a yellow stripe on top and sides, extending on the head, which is yellow in front; scutellum yellow; underside gray with yellow; legs gray; antennae gray. Sometimes the insect is entirely yellowish brown (var. adspersa).

Distribution. This species has been recorded by Leng and Hamilton, from the following localities: Canada, Wisconsin,

Lake Superior, Michigan, Ohio, Pennsylvania, New York, Massachusetts, New Jersey, Missouri, Kansas, Nebraska, Iowa, Vancouver island, British Columbia, and from Yakima Wash. by Professor Piper. We have seen specimens from Texas, South Carolina, Illinois, Black hills, and Bismarck N. D. It has been found by us at Fort Lee N. J., in New York city and also Brooklyn and Glendale.

Saperda adspersa Lec., a uniformly brown form described from Michigan, is a variety of this species. This variety has also been found at Albany [Joutel] and at Brandt lake in the Adirondacks [J. Doll].

Remedies. It is manifestly impossible to attempt to control this insect on other than valuable trees, and in such situations, digging out the borers, with possibly recourse to the use of repellent washes described on page 29, is about all that can be done and in the majority of instances should afford considerable protection.

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1891 **Beutenmuller, William.** N. Y. Micro. Soc. Jour. 7:31 (Bibliography of transformations)

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1899 **Lugger, Otto.** Minn. Agric. Exp. Sta. Bul. 66, p.215 (Injures poplar and cottonwood trees); same in Ent. State Exp. Sta. 5th Rep't, p.131

1899 **Smith, J. B.** Ins. N. J. List of Species, etc. State Bd Agric. 27th Rep't, sup. p.296 (Occasional through state in poplar and cottonwood)

1900 **Felt, E. P.** State Ent. 15th Rep't. N. Y. State Mus. Bul. 31, 5:557, 603 (Adults reared by Mr Adams from Populus monilifera July 18)

1901 ——— Am. Gardening, Aug. 10, 22:558 (Poplar borer is possibly S. calcarata, use of carbon bisulfid or potassium cyanid is advised)

1902 **Dury, Charles.** Cin. Soc. Nat. Hist. Jour. 22:163 (Listed, injures poplar)

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Saperda tridentata Oliv.

Elm borer

This species is of considerable economic importance, since it is sometimes very injurious to our American elms, where it may work in association with two small curculios, Magdalis barbita Say. and M. armicollis Say. We believe that this species is responsible in a large measure for the dying condition of some of our elms, though the curculios mentioned above undoubtedly aid materially in the work of destruction.

Early history. The earliest record of injury by this insect is that given by Harris in his report, *Insects Injurious to Vegetation.* He states that trees on Boston Common "were found to have suffered terribly from the ravages of this insect. Several of them had already been cut down as past recovery; others were in a dying state; and nearly all of them were more or less affected with disease or premature decay." Dr S. A. Forbes, state entomologist of Illinois, in his 14th report, states that, from the rapid progress which this pest has made among the elms during the last two or three years, it seems extremely likely that it will totally exterminate the trees unless it be checked by general action. Dr J. A. Lintner, late state entomologist of New York, in writing of this insect in 1893, characterizes it as being generally destructive throughout the State and one worthy of close attention in order to check or to prevent its causing serious injuries. Professor Garman, entomologist of the Kentucky Agricultural Experiment Station, records an instance of serious injury by this pest to trees about the streets of Frankfort. Several trees were dead and a number of other valuable elms dying, those affected being among the largest

and the finest in the city. A more recent outbreak at Berlin Mass. was brought to the writer's attention in 1898. Two long rows of rather young elms were seriously injured by this insect and the associated Magdalis armicollis Say and M. barbita Say, and a number of the trees were killed.

Signs of attack. The presence of this insect is not easy to detect till it has become well established, and the first signs are usually seen in the lighter, thinner foliage followed by a dead limb here and there. Indications of boring soon appear, and the dark sawdust collects in crevices of the bark, and, after the attack has progressed for some time, large portions of the bark may be easily pulled from the tree, revealing a condition beneath very much like that represented on plate 11, figure 2. The inner portion of the bark may be literally a mass of mines or burrows, and, if the work has not gone too far, numerous whitish, flattened, legless grubs may be found in the channels they have excavated. The junior author is of the opinion that this species normally feeds on dead or badly diseased tissues, and that from them it may invade living bark. A small portion of the work of this insect is shown on plate 3, figure 1, where it is seen that the grubs have made incursions into the living bark, working back to that which is dead. It is also able to live in the thick bark of older trees for a portion of its life. This is undoubtedly true in some cases at least, and in others it certainly appears as though this species was the initial cause of the trouble. The observations of Mr M. F. Adams on a large number of injured trees in the vicinity of Buffalo led him to attribute the primary injury to this species.

Life history. The time necessary for this insect to complete its life cycle is unknown, but from our breeding experiments it seems that probably only one and possibly two years are necessary. The larvae commence transforming to pupae in New York State about the middle of May or earlier, and the beetles begin to appear the latter part of that month and continue to emerge for some time, examples having been taken as late as Aug. 24. The eggs are deposited on the bark in June, according to the

observations of Dr Fitch, but it would seem very probable that oviposition may occur much later, as beetles are abroad till into August. The attack usually begins at the base of the tree. The young grub works its way under the bark and begins feeding on the tissues and making a serpentine burrow. The boring increases in size with the growth of the larva [pl. 3, fig. 1], and in the course of time the tree may be completely girdled and then it must soon die. Dr Packard, writing in 1870, calls attention to finding three sizes of larvae; and we found it comparatively easy to separate those taken from a badly infested piece of limb in a similar manner. But in our breeding from such infested bark all larvae transformed the same season. We have also found it working in dead as well as living tissues and have proved its ability to complete its transformations in the former.

Food plants. This insect appears to infest the white elm almost exclusively, though Dr Fitch records it as breeding in the slippery elm. We have seen no indications of its attacking the English or Scotch elms, so common in Albany. There is a record of this species having been reared from maple, but it would seem that the infestation must have been abnormal or else the record was founded on an erroneous observation.

Description. Black, sometimes fawn color, densely covered with a gray pubescence [pl. 3, fig. 3]. Thorax: twin black spots below lateral orange red bands which are joined together at the base and reach to the head, where each divides and encircles an eye; sometimes ornamented with two black spots on each side of median line. Elytra: submarginal ridge reaching from the humeral angle to near the apex, giving them an angulated appearance; ornamented by a more or less distinct submarginal, orange red band, from which arise three crossbars of the same color, the one nearest the base of the elytra nearly transverse, except at the tip, where it is sometimes oblique, it rarely reaches to the suture and has a black spot on either side where it joins the submarginal band; the middle band oblique and usually joined at suture; the apical one also oblique, with a black spot at its posterior side, usually reaches the suture and

continues to the apex, where it joins the submarginal band. The apex is truncate and usually sinuate in well developed examples.

Distribution. The elm borer is generally distributed in New York State and has been recorded by various writers from the following additional localities: provinces of Ontario and Quebec, Massachusetts, Rhode Island, New Jersey, Pennsylvania, Ohio, Kentucky, Illinois, Michigan, Wisconsin and Iowa. It was collected by Professor Bolles in Texas and at Tyngsboro Mass. by Blanchard. We have also seen specimens from the District of Columbia. It probably occurs in a number of other states.

Remedies. Badly infested trees should be cut and burned before the beetles have had an opportunity to emerge in the spring, that is before the latter part of May, in the latitude of New York. And in a like manner infested portions of others should be cut away and burned. The latter process was carried out on a lot of 1500 elms at Buffalo N. Y. by Mr M. F. Adams, who reports that the trees were benefited in a most gratifying manner.

Protecting the trees during the period of oviposition with a carbolic acid wash has been frequently recommended, but is of doubtful utility. Where this insect is very abundant and its injuries correspondingly serious, it would do no harm to try the effects of a wash. One of the best may be prepared as follows: thin a gallon of soft soap with an equal amount of hot water and then stir in 1 pint of crude carbolic acid, or ½ pint of the refined, and allow it to set over night. The next day add 8 gallons of soft water and apply to the parts to be protected, which in the case of this insect would be the trunk and base of the lower limbs. The bark should be kept moist with this substance from the latter part of May through July.

Removing portions of the bark has also been recommended. The badly infested portion should be cut away and the grubs destroyed, and, where a few are working in living bark, it might be well to remove the upper layers till the grubs are nearly exposed and then brush over the shaven surface with strong kerosene emulsion or whale oil soap solution, finally covering the wound with a paste formed of a mixture of fresh cow dung and lime or with a coat of cheap, red paint.

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1899 **Lugger, Otto.** Minn. Agric. Exp. Sta. Bul. 66, p.215 (Mention); same in Ent. State Exp. Sta. 5th Rep't, p.131

1899 **Smith, J. B.** Cat. Ins. N. J. State Bd Agric. Rep't, sup. p.297 (On elm)

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Saperda cretata Newm.

Spotted appletree borer

This insect is the more common appletree borer in Michigan, where it inflicts serious injuries according to Professors Cook, Riley and Osborn. It is probably this insect that Mr L. J. Templin had in mind in 1877 when writing of the appletree borer in the *Practical Farmer* for Nov. 17. He states that in the West a "majority of the specimens have a spot on each elytron on the shoulder," and shows that it was quite injurious even at that early date. It also works in the lower limbs of Crataegus, as stated by Dr Hamilton. Professor Osborn has recorded this insect as inflicting considerable injury in Iowa.

Description [pl. 4, fig. 2]. Cinnamon brown with a white band on the side of thorax, and a large, oblong white spot twice as long as wide, at middle of each elytron, and another small spot before apex; neither reaching to suture or margin. There is sometimes a minute white spot at middle of base of thorax as well as at the humeral angles. The sides are white; underneath, brown.

Distribution. This species has been recorded from the following localities: Paris Ont. [E. B. Reed], New York and Pennsylvania [Hamilton], New Jersey and Ohio [Chittenden]; Mr Chittenden states that there are specimens of this insect in the United States National Museum from northern Illinois and Texas; Leng and Hamilton record it from the following localities: Massachusetts, Canada, Michigan, Wisconsin, Iowa, Illinois and Pennsylvania; and Mr Wenzel informs us that he has recently taken it at Philadelphia. Mr Blanchard took it at Tyngsboro Mass.

Food plants. This species, in addition to the apple, attacks wild crab apples, and it has been observed on Juneberry [Chittenden].

Life history. Professor Osborn has observed the work of this insect quite closely. He states that its attack is usually confined to branches of moderate size, and that its plan of work is somewhat peculiar. At intervals of half an inch or more along the branch double incisions are made in the bark; and, on cutting these away, it was found that they led to excavations of considerable size under the bark, in some of which small grubs could be found at work. The borers had the appearance of the common appletree borer and were evidently of one year's growth. This insect makes a longer, more tortuous burrow than calcarata, in our experience. Its work in thorn is represented on plate 4, figure 1.

The pupa as described by Professor Osborn is similar to that of S. candida but smaller and occupies the central portion of the branch. He further observes that the beetles issue about the middle of June, and, after pairing, the female lays her eggs in the bark, two in a place, distributing them along the branch at distances of half an inch to an inch. On hatching, the grubs work in opposite directions around the branch, living for the first year just beneath the bark and afterward entering the solid wood. Here, after becoming full grown, they pupate and in due time complete their transformations.

Remedies. The remedial measures advised by Professor Osborn are cutting out and destroying the grubs with as little injury to the bark as possible; and, as he observes, if this is done soon enough, two grubs may be killed at every incision. He also states that some of the smaller woodpeckers are likely to prove most effectual allies in controlling this insect, and their presence in an orchard should be encouraged. Professor Cook has advised the use of the carbolic soap wash, which he states should be applied about June 10.

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Saperda discoidea Fabr.

Hickory saperda

This species is remarkable in having the sexes so unlike that one unacquainted with it would certainly consider them distinct species. In a long series of males, however, there will be found individuals having the same color and markings as the females, and some very poorly developed females lack entirely the characteristic markings of the sex. This is a common insect and breeds abundantly in hickory, frequently following the work of the destructive hickory bark borer, Scolytus quadrispinosus Say. It is sometimes so abundant that a piece of bark 6 inches square may contain a dozen or more larvae.

Life history. The beetles have been taken abroad the latter part of June and in July. The larvae feed partly on the bark and partly on the wood and on approaching maturity, in our

experience, enter either the bark or the wood and transform to beetles. The work of this species is shown on plate 3, figure 2. Dr Hamilton has found more than 20 larvae, pupae and immature beetles, in the bark of a large hickory that had been killed about two years before. All were on the north side of the tree and none over 15 inches from the ground. In our experience they are equally abundant on all sides of the tree but appear to avoid any part infested by a dense white fungus growing between the bark and wood and often into the wood, and as very often only one side of the tree is so affected, this may account for the experience of Dr Hamilton. Dr Horn states that the larvae fed on the outer layers of the wood till they had attained nearly full growth and then retired into the bark, closing their burrows and transforming like a species of Urographis in oak.

Food plants. This insect appears to confine its attack to diseased or dying trees. We have reared it from trees killed by Scolytus quadrispinosus Say. It has been recorded on the hickory by Mr Harrington and as common on hickory and walnut in southwestern Pennsylvania by Dr Hamilton.

Description [pl. 3, fig. 5, 6]. Color above varies from black to light reddish brown in some examples; thorax and elytra strongly punctate; legs reddish brown, darker toward the tarsi. The under side is white in the males and light yellowish gray to light gray in the females.

Female. Head and thorax covered with olive yellow hair; scutellum yellow; the elytra denuded, except a small spot above and one below; a crescent-shaped fascia in the middle of each elytron, composed of dense yellow hair, which also forms a marginal band spreading over the apical end of the elytra.

Male. Uniformly ferruginous, black above, covered by a sparse gray pubescence that forms a whitish line on the sides and dorsum of the thorax, which is bordered by a denuded area.

Distribution. Middle states [LeConte]; Buffalo N. Y. [Zesch-Reinecke]; never plentiful about Hamilton Ont., though the females are usually the more numerous [Moffat]; very rare at Ottawa Can. [Harrington]; locally not rare throughout New Jersey [Smith]; and from Canada, New York, Pennsylvania,

New Jersey, Louisiana, Kansas, Nebraska, Illinois, Michigan [Leng-Hamilton].

Natural enemies. Mr Harrington has observed a species of Arotes ovipositing in infested hickories and it is possibly a parasite of this borer.

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Saperda vestita Say

Linden borer

This species is a serious enemy of lindens in this country and is therefore one of considerable economic importance.

Early history. Dr Harris has recorded extensive depredations on linden trees in Philadelphia by an insect supposed to belong

to this species, but, as the workings are very different from any we have met with, we question the identity of the depredator. The trouble was so serious that 47 trees were cut down by order of the authorities. The nature of the injury may be judged by the following. One of the infested lindens was very large, the trunk measuring 8 feet, 5 inches in circumference 5 feet from the ground. A strip of bark 2 feet wide at the bottom and extending to the top of the trunk was destroyed, and the exposed surface of the wood pierced and grooved with countless numbers of holes where borers had bred and where swarms of the beetles were supposed to have issued in past times. Some of the larger limbs and a portion of the tree broke off, apparently the consequence of the ravages of this insect. This pest has been very injurious to the European linden at Cambridge Mass., and Professor Webster has recorded it as damaging young lindens in nursery rows.

Life history. The beetles appear toward the end of the summer (we have taken them in August) and feed on the bark and the leaf petioles and also the larger veins on the under side of the leaves and on the green bark of the growing shoots, often killing the tips of the branches. When the beetles are very abundant, the injury caused by them is quite noticeable. Professor Smith has observed this beetle abroad in New Jersey during July, and Dr Packard states that one female may contain as many as 90 eggs. A female is said to deposit her eggs, two or three in a place, on the trunk and branches, specially about the forks, making slight incisions and punctures for their reception with her strong jaws. The larvae undermine the bark for a distance of 6 or 8 inches from the place where they hatch and often penetrate the wood to an equal extent, as stated by Dr Packard, who adds that this insect works at the base of young lindens, gouging two parallel rings around the trunk and forming annular swellings. We have observed the work of this species and seldom found it more than 12 inches above the ground; and in our experience it occurs very largely in exposed roots and subterranean parts, though Mr D. B. Young states that he has taken this beetle from galleries in the lower limbs of a large

tree. The method of work is shown on plate 5, figure 1, which represents the broad galleries of the larva and the exit hole of the beetle. Our observations are confirmed by Professor Webster, who also states that the pupal cell is made at about the level of the ground and is cut diagonally across the grain of the wood and at an angle of about 45° to the channel the larva makes when ascending to this level.

Food plants. Linden is the greatest sufferer from the ravages of this insect, though it has been recorded by Dr Packard as infesting poplar, as occurring on ? elm by Riley and Howard, and Rev. J. L. Zabriskie has taken the insect from appletrees. It is doubtful, in our judgment, if the insect breeds in other than the various lindens.

Description [pl. 5, fig. 5]. Black, covered by a dense olivaceous pubescence, usually with three denuded spots on each elytron, two placed obliquely above the middle and one below. One or all of these spots may occasionally be wanting.

Distribution. This insect has been recorded from localities as follows: Lake Michigan [Say]; rare in Massachusetts [Harris]; very abundant in Lancaster county, Pa. [Rathvon]; Middle and Western states [LeConte]; Amherstburg Ont. [E. B. Reed]; Buffalo [Zesch-Reinecke]; L' Original and Grenville Can. [Harrington]; rather common in New Jersey [Smith]; not rare on linden in southwestern Pennsylvania [Hamilton]; very common [Provancher]; Canada, Vermont, New Hampshire, Massachusetts, New York, Pennsylvania, Michigan, Wisconsin, Iowa, Illinois, Ohio, New Jersey [Leng-Hamilton]. We have also seen specimens from Missouri.

Natural enemies. Two enemies have been bred from this species, one, Bracon pectinator Say? from the insect in ? elm and another, B. charus Riley, which is given by Dr Packard on the authority of Riley's unpublished notes, and, as no food plant is given, it is possible that the latter is but a different name for the insect previously mentioned.

Remedies. It is manifestly impossible to attempt to control this insect on other than valuable trees, and in such situations, digging

out the borers, with possibly recourse to the use of repellent washes described on page 29, is about all that can be done and in the majority of instances should afford considerable protection.

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Saperda imitans n. sp.

This interesting species resembles our common elm borer, S. tridentata, with which it has frequently been confused. The junior author bred this insect some years ago from wood collected near the city of New York, but he did not notice that it was distinct from our common elm borer till too late to examine its workings. He had no elm in the breeding cage at the time, and so presumes that it lived in hickory, of which he had a quantity.

Description [pl. 3, fig. 4]. Black, densely covered with a gray pubescence, whiter below. Thorax: twin black spots below a lateral orange red band, extending on the head to the eyes, where it joins the line of the opposite side; median line light. Elytra: submarginal band of orange red running to the apex, from which arise three crossbars of the same color, each obliquely inclined toward the suture, the middle band usually not connected to the submarginal, the apical band usually rudimentary and then only transverse; apex rounded.

Types in collection of L. H. Joutel and New York State collection.

This insect is often mistaken for tridentata, but can be easily separated by the following characters, which show it to be

distinct and not even closely related. It is longer in proportion to its width than tridentata. The sides are parallel, while in tridentata the humeral angle is quite pronounced. The first crossbar is oblique, there are no spots on each side of it, and the spot is also lacking behind the apical crossbar; it also wants the submarginal carina present in tridentata, which has the first crossbar at right angles. The pygidium of the female is broader at the top, and the sides make a wider angle than that of tridentata.

Distribution. This species has been received from Montreal Can.; and Mr Fred Blanchard has taken a specimen at Tyngs-

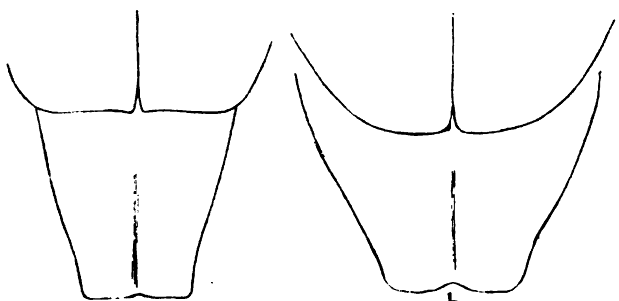

Fig. 5 **Last dorsal segment and apex of elytra of S. tridentata (*a*) and S. imitans (*b*)**

boro Mass. Mr Roland Haywood has taken it near Boston; specimens have been seen from Virginia, Michigan, Pennsylvania and Wisconsin; and we have bred it from New York city and vicinity.

Saperda lateralis Fabr.

Red-edged Saperda

This species is about the same size as S. tridentata Oliv. and like it occurs in elm. Its principal food plant is hickory, on which it is partial to injuries near the roots and to the base of sprouts on recently cleared lands. It is rarely abundant enough, however, to cause serious injury.

Life history. Comparatively little has been published concerning the life history of this species. The beetles may be taken in June in northern localities, and, like most other Saperdas,

feed on the bark and petioles of the leaves at the ends of the shoots. Mr Tolman found them pairing in June on a fallen hickory near Philadelphia. We have bred this species from hickory stems in which the larvae lived at the juncture of the dead and living bark. Mr S. T. Kemp records the fact that he found the larvae of this species inhabiting the base of dead shoots of hickory, and, on breaking off the shoots, the borers were almost entirely exposed, sometimes falling to the ground. The infested shoots were invariably those which had been broken off 3 or 4 feet above the ground by the larvae of Elaphidion villosum Fabr. the previous season. The grubs of these work at the very base of the tree and burrow almost laterally and slightly upward. In addition to food plants mentioned above, Dr Packard records breeding the species from alder, but this appears to be exceptional.

Description [pl. 7, fig. 8]. Black, sometimes brownish black, coarsely punctured and covered with brownish black pubescence above and gray below. Antennae black; thorax with two black spots below, a lateral orange red band that extends on the head to the eyes and joins at the apex; the elytra have a submarginal band that connects with the thoracic one at the humeral angle and at the rounded apex joins a sutural band, which is sometimes wanting. This species is remarkable in that the male possesses a tooth or process on all its claws.

Connecta n. var. [pl. 7, fig. 9]. Like the species in color but lacks the sutural line; the submarginal band extends to the margin; and it has three oblique lines on the elytra, the apical one rudimentary and the middle one broad. Dr Fitch has described two varieties, abbreviata and suturalis, which are characterized simply on the width of the sutural and submarginal stripe. Types in the collection of L. H. Joutel.

The variety connecta is connected with the species by intermediate forms in all stages of development, from those that have a slight mark at the marginal band or at the sutural one or both, to those that have the two bands in various stages of development [fig. 6].

Like imitans, this variety has been confused with tridentata, which it somewhat resembles. It can be easily separated from that species and imitans by the punctures, the brownish black pubescence above, the shape of the elytra and the rounded head. This form occurs with the type and is more common westward.

Distribution. This insect has been recorded from the following localities: Cliftondale Mass. [Henshaw], Buffalo N. Y. [Zesch-Reinecke], Philadelphia Pa. [Tolman], Hull and Ottawa Can. [Harrington], Montreal Can. [Caulfield], Providence R. I. [Packard]; is not rare in southwestern Pennsylvania [Hamilton]; Canada, Vermont, Massachusetts, New York, Pennsylvania,

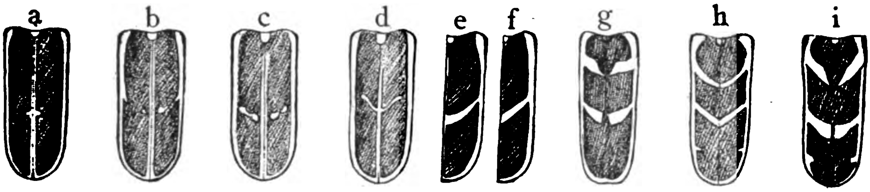

Fig. 6 *h*, *i* S. lateralis var. connecta. *a-g* intermediate variations between S. lateralis and var. connecta

New Jersey, Virginia, West Virginia, Ohio, Michigan, Wisconsin, Illinois, Iowa [Leng-Hamilton]. We have taken or bred it from Fort Lee N. J., Bronx park New York city, and Brooklyn N. Y.; it is also found in Nebraska and Massachusetts, and is common in Kansas. The variety connecta is occasionally found in New York and Massachusetts and in numbers in Kansas, Nebraska, Illinois and Wisconsin.

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Saperda fayi Bland.

Thorn limb borer

This species breeds in the small limbs and stems of wild thorn (Crataegus crus-galli and C. tomentosa), creating gall-like, gnarly swellings and weakening the branches so that they sometimes break off in the wind. This insect is widely distributed in New York State, though quite local. It displays a marked fondness for certain trees, in which it will breed year after year while others near by will be practically unaffected. Should this species, like its allies, acquire a taste for our cultivated fruit trees, it would never prove as dangerous an enemy

as the round-headed appletree borer (S. candida Fabr.) as the galls would indicate the injury and could easily be cut off.

Life history. The beetles [pl. 6, fig. 4] appear in New York State during the month of June, the exact date varying according to the season, the males preceding the females by three or four days. They do not appear to eat and are short-lived, while the whole brood, excepting the stragglers, appear and disappear within the space of 10 or 12 days, so that close observation is necessary in order to capture many. The late Dr J. A. Lintner has taken this species June 25 at Schenectady, and Mr Moffat collected beetles at Hamilton Ont. June 15, while Mr Zimmerman records the capture of a female Aug. 15.

The males watch for the appearance of their consorts and pairing usually lasts three or four hours, according to Dr Hamilton. The beetles fly but little and usually oviposit on the tree they inhabited as borers, which explains the local character of the species. The insects are sluggish and, when suddenly approached, drop to the ground and endeavor to conceal themselves. Egg-laying probably occurs during the night, though the process has not been observed. Small limbs, varying in size from $\frac{1}{8}$ to $1\frac{1}{4}$ inches in diameter, are selected for this purpose, and, according to the thickness of the limb, the female uses her mandibles to make from three to six longitudinal insertions through the bark, each being about $\frac{3}{4}$ inch in length, parallel to one another and dividing the circumference of the trunk or limb into nearly equal sections. An egg is deposited in each of these slits, and as soon as hatched the larva at once makes a burrow beneath the outer layer of the wood, perhaps $\frac{1}{8}$ inch in length, and uses this as a retreat from which it issues to feed on the wounded tissue caused by the irritation. These slits and the irritation caused by so much cutting produce an increased flow of sap to the wound and a consequent thickening of the portions between the slits, so that the affected part soon assumes a gall-like appearance.

The work of this species is shown on plate 6, which represents a twig on the lower portion of which are two old galls with irregular, decaying, overgrown cavities [fig. 1], which are quite different from more recent galls [pl. 6, fig. 2]. The borings of

the larva in a young gall are shown in section on plate 7, figure 2, and the manner in which the stem may be eaten by a larva working in its center at figure 2a [*See also* pl. 13].

The larvae are ¼ inch long on the approach of winter, according to Dr Hamilton's observations, when they retire into the wood a little farther and close the opening of their burrows with borings. One of the larvae, and in thick limbs two or three, bore obliquely till one of them reaches the center of the limb, up which it proceeds often two or three inches. The others parallel this gallery but maintain a partition between the burrows. The larvae near the center are much larger, often twice the size of those inhabiting the outer wood, and are the only ones that produce beetles, as stated by Dr Hamilton. In our experience the different sized larvae indicate male and female and unless parasitized all emerge.

We can not entirely agree with the following observations regarding this species also by Dr Hamilton:

The whole of the interior of the limb is now dead wood inclosed by a growth of living but unsound woody tissue, through which some openings remain. Many of the larvae in the outside wood perish during the winter, and the survivors, after feeding a while in the spring, likewise die, their mission seeming to have been merely to insure a sufficiency of dead wood to sustain the life of the favored few destined for full development.

The larvae in the deep wood return in the spring and feed on the dead tissues, which are now abundant enough for all their wants, and by autumn they are nearly full grown. Some of the larvae do not return in the spring of the second year to feed on the dead wood at the entrance of the burrow, but bore directly up and down the center of the limb for a distance of 16 to 24 inches before pupating. Those which feed on the dead wood near the entrance to the wound are nearly full grown by autumn. They again retire for the winter and in the spring, after opening up communication with the outside world, feed for a short time and when full grown measure about ¾ inch in length. They now return to their burrows for the final transformations. Some of

them bore for at least six inches, while others scarcely go from the entrance more than twice their own length. The outer ends of the burrows are closely packed with borings without and soft fibers within, which also fill the inner ends. The head of the larvae may be either toward or away from the opening, seemingly a matter of indifference. In the former case the beetle emerges from the place of entrance and in the latter, from a round hole at right angles to the burrow, probably made by the beetle itself, as no such hole has been detected in the many limbs Dr Hamilton examined, containing pupae with their heads turned from the opening. Pupation occurs after the middle of April. We have found them transforming at Albany Ap. 16. The beetles may be found in the limbs about the first of May, though but few of them emerge till the latter part of the month.

Description [pl. 6, fig. 4]. Cinnamon brown, below gray, white at sides, being of the same color as cretata. Thorax with lateral white band that extends on to the base of the elytra, which also have two crescent-shaped, white spots at middle, divided by the suture, and two smaller circular ones near the apex, also divided by suture. These spots may be nearly or quite obsolete, usually in the male. The antennae darker than cretata.

Distribution. This insect has been recorded from Buffalo N. Y. [Zimmerman]; Hamilton Ont. [Moffat]; and Dr Hamilton reports it as common in Crataegus limbs in southwestern Pennsylvania. The types were described from Ohio; Dr Smith has recorded it from Greenwood Lake and Delaware Gap N. J., and it has been listed by Messrs Leng and Hamilton from Canada, New York, New Jersey, Pennsylvania and Ohio.

This species is not related to cretata, which it resembles in color, but has more of the characters of the less specialized species, as is shown by the short, rounded head and the but slightly developed process on the claws, that on the first pair being very rudimentary. This relationship is further emphasized by its gall-producing larva working in the same way as concolor.

Natural enemies. There are no records of any, but the species appears to be a favorite with some woodpeckers, since we have found a number of empty galls showing the characteristic work of these useful birds [pl. 13, fig. 1]. We have no clue to the identity of the species.

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Saperda puncticollis Say

Woodbine borer

This is one of the smallest and also the prettiest species belonging to this important genus. It is a rare form in most collections in spite of the fact that the insect lives in the dead branches of the common Virginia creeper, pupating in the wood. The manner in which the larva works just under the bark is shown on plate 6, figure 6. The entrance to the pupal chamber is stopped with a plug of borings

[pl. 6, fig. 8, 8a]. The general appearance of the larva is also represented. This species seems to be somewhat retiring in habit, and, while it has been collected on the leaves of its food plant, specimens are much more easily obtained by rearing the insects from infested twigs. We have often bred the species from Virginia creeper and have frequently examined much poison ivy where the insect was abundant, but have been unable to find it in that plant. We have taken it in June and July, and Mr Zimmerman records its capture at Buffalo in June. It is probably abroad during most of the two months.

Food plants. It has been recorded on poison ivy [Zimmerman], grape and probably Virginia creeper [Harrington], R h u s t o x i c o d e n d r o n and R. r a d i c a n s [Smith], as not common on R h u s r a d i c a n s in southwestern Pennsylvania [Hamilton], as bred from the larger living stems of Virginia creeper [Harrington], and as in the stems of poison ivy and oak [Lugger].

We find that the larvae feed on the inner bark of the branches and stems of Virginia creeper. This species is very subject to attack by woodpeckers, and we have seldom found the workings without evidence that a number had been destroyed by the birds.

Description [pl. 6, fig. 9]. Black, with a sparse black pubescence above and a dense gray one underneath. Head yellow with a round black spot in front and one on the vertex, antennae black; thorax yellow with a black spot at the side and four quadrately arranged on its dorsum; elytra with a broad, yellow marginal and a sutural band. The process is found only on the anterior claws of the middle pair of legs.

Distribution. It was described by Say from Arkansas; it has been taken about Buffalo by Zimmerman; about Ottawa Can. by Harrington; is reported by Smith as occurring throughout New Jersey; and by Hamilton as not common in southwestern Pennsylvania. LeConte gives its distribution as the Middle, Eastern and Western states; and Leng and Hamilton record it from the following localities: Massachusetts, New York, New Jersey, Pennsylvania, Ohio, Louisiana, Arkansas, Kansas, Nebraska.

We have bred it from stems of Virginia creeper gathered in and around New York city and also at Fort Lee N. J. It was described from Cambridge Mass. as S. trigeminata by Randall.

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Saperda populnea Linn.

This European species is found on the Pacific coast, and the examples from different localities now before us can not be distinguished in any particular from European specimens. With this species we include as subspecies the S. moesta of LeConte and a new form that differs from either, under the name tulari.

They differ from populnea as well as from each other in the punctures on the elytra as well as in the punctulations on

the intervals, also in color and vestiture, and while some specimens come very close to each other, we have seen no intergrades of color and vestiture. T u l a r i in character seems to us to be intermediate between m o e s t a and c o n c o l o r.

It may be well at this point to remember that our species have originated in the East, where all are found except two, p o p u l n e a and h o r n i i. Of these, p o p u l n e a has not specialized from the Old World form, as has h o r n i i, which is evidently descended from and is still closely related to s i m i l i s. C a l c a r a t a is the only one of our species that extends to the west coast, where it has been found by Professor Piper in Washington.

Bearing this in mind and remembering that m o e s t a, as a

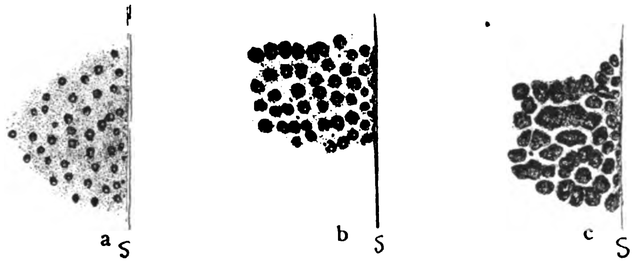

Fig. 7 Elytral characters of females: *a* tulari, punctures scattered; *b* moesta, punctures contiguous; *c* populnea, punctures confluent

unicolorous form, as we know it in the East, has not crossed the Sierras and has not yet been found on the coast, there can be no question of its being distinct.

T u l a r i, like m o e s t a, is evidently of American origin and not an emigrant from the Old World. The punctures and dense punctulations in the elytra show a wider divergence from p o p u l n e a than m o e s t a and connect that species and m o e s t a with c o n c o l o r.

Description S. p ò p u l n e a Linn. [pl. 7, fig. 4]. Black, shining, coarsely and deeply punctured, the punctures often contiguous and confluent on the elytra; a few punctulations which are sometimes wanting occurring between the punctures; sparsely covered with a light gray or fulvous pubescence; thorax with a lateral band of dense fulvous or yellowish gray hairs; elytra

with eight small spots of dense fulvous or yellowish hair, arranged in pairs, the first and third nearer the suture, the third pair being the largest; one or more pairs often obsolete, the third pair being the most permanent; antennae black, annulated with gray, first joint black.

S. moesta Lec. like populnea; but the vestiture is a uniform light gray without spots, and the lateral line on the thorax only faintly shown.

The punctulations on the intervals between the punctures are more numerous than in populnea.

S. tulari n. subsp. [pl. 7, fig. 6] like populnea and moesta; but the punctures, which are larger and deeper and usually with an edge, are not so numerous as in the other two species and seldom confluent; the intervals are densely punctulate as in concolor. It is densely covered with red or fulvous hair. Thorax with a stripe on side and a median band on top. Types in collection of L. H. Joutel and National Museum, Washington.

The above discriptions apply more particularly to the females.

Distribution. S. populnea, moesta and tulari. With the material before us, it may be well to revise the distribution of these species, which have been confused. As stated, moesta does not occur on the Pacific coast and so must be dropped from the lists of that section.

S. populnea. Well marked examples have been seen from Washington, Oregon, California, Spokane Wash. and Los Angeles county, Cal. In Europe it feeds in poplar and willow stems forming galls.

S. moesta. Canada to Wyoming, Idaho, Montana, Colorado, New York, Wisconsin, Pennsylvania, Buffalo, Montreal, Toronto, Lake Superior. It feeds in balsam poplar. Moesta has never been found in the vicinity of New York city to our knowledge; and the one from Staten Island cited by Smith in *Insects of New Jersey*, was probably concolor.

S. tulari. Tulare county, Cal., Yosemite Cal., Arizona, Nevada, Oregon, Washington.

Saperda moesta Lec.

This insect [pl. 7, fig. 5] confines its operations to the balsam poplar or balm of Gilead so far as known, and occasionally it is quite injurious to this tree.[1]

Life history. The beetles appear in June. Two sizes of larvae in gall-like swellings from 1 to 2 inches apart and in shoots about ½ inch in diameter were found by Mr Harrington in June. The late Dr D. S. Kellicott bred Sciapteron tricincta Harr. from enlargements in the branches and stems of the balm of Gilead and the common willow[2] which were caused by this species and its associate, Saperda concolor. Mr Saunders states that he received a bundle of balm of Gilead twigs on Mar. 25 which were infested with this insect. The larvae were very thickly set in the branches, in many places not more than an inch or two apart, and located chiefly at the base of the buds, where the presence of the occupant was indicated by a swelling in the branch which was surmounted by a dark brown patch of partly decayed bark. The castings and debris of the borer were of a light orange color and were pushed forward, stuffing the swollen part. The whole length of the excavation made by each larva did not usually exceed an inch, and so much of this was filled with debris that the clear space left was very little larger than its body. Mr Saunders describes the larvae as follows:

Body above deep yellow, with a glossy surface, sprinkled with very minute, short yellow hairs, invisible without a lens. Second segment above and below a little deeper in color and more horny looking than the other segments; interspaces between segments strongly indented. There was a depressed dorsal line not different in color from the rest of the body, but sunken, and on each side of it the projecting rings of the body were somewhat flattened. Spiracles pale brown, rather small. Terminal segment a little more hairy than the others.

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[1] Mr Charles Stevensen, of Montreal, kindly sent us some fresh galls of Saperda moesta, from which the illustrations were made and a number of specimens reared.

[2] Moesta probably caused the galls in balm of Gilead, and concolor those in the willow.

The bunch of twigs received Mar. 25, as above stated, were examined by Mr Saunders May 2, when he found that no pupal inclosure was to be seen, though the head, antennae and legs of the beetle were fully developed, while the wings and wing cases were only partially so. On May 16 the wing cases of one beetle were full length but not fully expanded, while in another case they were fully developed. The twigs containing these insects had been kept in a dry room and hence they were quite dry and brittle. Fresh twigs received May 24 showed that a considerable number of the occupants had been eaten by woodpeckers, though some five or six specimens were found in pupal cells, one of which was occupied by the pupa of a parasite. The pupa of this Saperda has been described by Mr Saunders as follows:

Body semitransparent; color uniform pale yellow, except the eyes and mandibles, which were black; the jaws were faintly tipped with brown and a faint brown line down each side of the scutellum. All the parts of the insect were plainly visible throughout the pupal case. The wings were very small and diverged to each side of the scutellum.

May 29 two of the pupae from the fresh lot of twigs had become perfect beetles, and early in June all had completed their transformations and escaped through neat round holes.

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[1] This also comprises what was formerly referred to m o e s t a and includes p o p u l n e a and t u l a r i.

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Saperda concolor Lec.

This species, which requires but one year to complete its transformations, so far as our observations go, girdles the trunks of sapling poplars by running a mine around them, which causes a swelling often nearly twice the size of the diameter of the tree, as described by Dr Packard. It infests dwarf willow canes as stated by Dr Hamilton; and the following is from his account of the insect.

Life history. The beetles appear from the last week in May till after the middle of June. The smaller canes, ¼ to ¾ inch in diameter, of Salix longifolia growing along water courses are usually selected by this insect for breeding places. The beetle gnaws a longitudinal incision through the bark, about ¾ inch in length, and deposits an egg in each end. Several are usually made in the same cane some distance apart and these often cause its death the following year. A warty, gnarly swelling occurs around each incision [pl. 6, fig. 14]. The young larvae [pl. 6, fig. 12, 13] follow the same course as those of S. fayi, only they burrow deeper into the wood, and there are no supernumeraries, as there is no need of them, since the wood of the willow dies much more quickly than that of Crataegus.

The beetle, however, does not always select the smaller canes for oviposition, sometimes choosing those from 1½ to 2 inches in diameter, when the larvae pursue a different course, for, instead of boring up and down, they take a transverse direction and girdle the stem ⅓ to ½ its circumference, causing a rough annular swelling and frequently killing the cane.

The head of the pupa is toward the opening from which the perfect insect emerges. S a l i x c o n c o l o r appears to be its natural food, and, did this beetle confine its attention to this shrub, it could hardly be classed as injurious; but in the vicinity of Providence R. I., at least, it has inflicted considerable damage on the common poplar. Two parasites, P i m p l a p e d a l i s and a species of Bracon, have been reared from the galls of this insect by Professor Davis.

Description. Black, finely punctulate, and with numerous small, shallow punctures; entirely covered by a dense gray or yellowish gray pubescence except at the top of the thorax, where it is less dense, this giving it a darker appearance and increasing the effect of the lateral band; a slight median line on the thorax; antennae black, annulated with gray. Var. u n i c o l o r n. var. [pl. 6, fig. 15]. Like type, but pubescence uniformly dark gray and finer. The punctures are much more numerous than the type and are apt to be confluent. This variety is the eastern form and is named as we believe it to be the ancestral form of the species.[1]

Distribution. This insect has been thus recorded: Sante Fe N. M. [LeConte], Cliftondale Mass. [Henshaw], Buffalo [Zesch-Reinecke], Providence R. I. [Packard], Allegheny Pa., Texas, Michigan, Canada and New York [Hamilton], New Jersey [Smith], Ohio [Kellicott]; rare [Provancher], Canada, Massachusetts, New York, New Jersey, Pennsylvania, Michigan, New Mexico [Leng-Hamilton] Arizona.

[1]This insect is often confused in collections with m o e s t a and M e c a s i n o r n a t a. The type form is from New Mexico, and the same form has been received from Arizona. Var. c o n c o l o r is from the other localities above and also from Idaho, from which an intermediate form has been received. There is no question of their being forms of one species, the change being due entirely to climatic influences. It is very close to t u l a r i.

Remedies. Dr Lugger advises the use of a soft soap and paris green wash as a preventive of oviposition. He states that the presence of the larvae is also easily discovered by the discolored blotch on the bark and by the little heaps of sawdust that are pushed out by them during their boring operations.

The grubs may be killed by means of a wire or with a pruning knife.

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EXPLANATION OF PLATES[1]

PLATE 1

Saperda candida

Appletree borer

1 Beetle at rest on the bark

2 Scar indicating the presence of a young grub beneath and also showing a characteristic oviposition slit

3 Sawdust or borings ejected by half or two thirds grown larva. This is usually found very close to the base of the tree.

4 Exit hole of the beetle, in section

5 Borer or grub preparing its pupal chamber

6 Pupal chamber with exit hole of beetle shown at 7

8 Blackened old burrow seen in trees attacked a year or two earlier

PLATE 2

Saperda calcarata

Poplar borer

1 Beetle at rest on the bark

2 Pupa in its chamber, and below it a mass of long fibrous tissues, partly torn from the sides of the burrow

3 Larva or borer in its gallery. This illustration shows the expanded character of the burrow near the orifice through which the larva ejects its numerous borings. The blackened appearance of old galleries is also represented, as well as their occurrence at different depths in the wood.

[1] Executed from nature by the junior author, L. H. Joutel, New York.

PLATE 3

1 Portion of elm bark illustrating the work of the larva of the elm borer, Saperda tridentata. It will be seen that many of the borings are in dead tissues, and that a few extend into the living bark, which apparently gradually dies and permits the insect to extend its operations over a considerable area.

2 Piece of hickory bark illustrating the work of the larva of S. discoidea. The white sawdust excavated from a pupal chamber made in the wood is shown at *a*, and a pupal chamber in the bark is represented at *b*.

3 S. tridentata

4 S. imitans

5 S. discoidea, female

6 S. discoidea, male

PLATE 4

Saperda cretata and **concolor**

Spotted appletree and *willow borers*

1 Work of S. cretata in thorn, showing the irregular character of its galleries, and the different depths at which they occur

2 Adult beetle

3 S. concolor, enlarged

4 Work of this species or possibly S. tulari in Arizona willow. This illustration represents the peculiar gall, the general form of the galleries and pupal cell, with the exit hole in section.

PLATE 5

Saperda vestita and **obliqua**

Linden and *alder borers*

1 Portion of the base of a linden, showing the work of the larva of S. vestita, and at *a* the circular exit hole of the adult

2 A small alder stem, showing the enlargement produced by the larva of S. obliqua a year after the stem had been deserted

3 An alder stem showing the external appearance, indicating recent operations of the larva of S. obliqua and at *b* the pupal cell with the mass of borings blocking one end

4 Section of alder stem showing the method of work of the larva of S. obliqua

5 S. vestita, female

6 S. obliqua

PLATE 6

Saperda fayi

Thorn borer

A Branch of the thorntree showing the galls and work of this species

1 An old gall with a larger one just below it

2 Section of a fresh gall showing the work of the larva

2a Borings in the stem

3 Exit hole of the beetle in section

4 Adult, enlarged

Saperda puncticollis

Virginia creeper borer

B Portion of Virginia creeper, representing the galls and work of this species

5 Section of the stem, showing the pupal chamber

6 Larva at work under the bark

7 Exit hole in section

7a Exit hole

8 Section of thin bark and sawdust stopper closing opening to pupal chamber

8a Same shown in a surface view

9 Beetle, enlarged

Saperda concolor var. unicolor

Willow borer

C Branch of poplar, showing the galls and work of this insect

11 Fresh galls and exit holes of beetles

12 Fresh gall cut open and showing the pupal cells: one empty, one occupied, and one extending up and the other down

13 Section of old gall showing the internal appearance of the tissues

14 External appearance of old galls

15 Beetle, enlarged

PLATE 7

1 Saperda calcarata var. adspersa
2 S. mutica
3 S. hornii
4 S. populnea, enlarged
5 S. moesta. The long line at its side shows the average length of Idaho specimens, the short one, that of New York, Canadian, and west of Wisconsin to Michigan specimens.
6 S. tulari, enlarged
7 Galls of S. moesta
   A Young gall shows wound caused by female
   B Exit hole
8 S. lateralis, enlarged
9 S. lateralis var. connecta, enlarged
10 Galls of S. moesta, with one cut open showing the pupal chamber
   A Oviposition scar
   B Exit hole of the beetle

PLATE 8

Early work of **Saperda candida**

Appletree borer

1 Ovipósition scars made by the female
2 Borings or frass thrown out by young grubs working under the bark
3 Bark cut away, showing the young larva in its gallery and its method of work
4 Scar showing old, overgrown exit hole
5 Upper portion of the wound caused by the insect, which emerged several years before at 4

The number of grubs in this small stem, which is only about $1\frac{1}{4}$ inches in diameter, is sufficient to kill a tree.

PLATE 9

Advanced work of **Saperda candida**

Appletree borer

This represents the appearance in section and lower portion of a very badly infested stem of a young tree, and shows

that it may be practically riddled before death ensues. The exit holes seen in the upper portion are by no means unusually abundant and such severe injury is certain to result in the death of the tree.

PLATE 10

Advanced work of **Saperda candida**

Appletree borer

1 Base of two year old tree killed by borers

2 Young tree entirely girdled by two borers, showing two exit holes, and at *A* the only connection with the root

3 Young tree killed by borers: *AA* shows the only connection with the root and *B* is a bare area which the tree has tried to cover with living tissue.

PLATE 11

Early work of **Saperda calcarata**

Poplar borer

1 This represents the early galleries and illustrates how a few larvae can easily girdle a young tree, because of their running a portion of their burrows transversely in the inner bark and outer sapwood.

2 Advanced work of S. tridentata, elm borer

PLATE 12

Advanced work of **Saperda calcarata**

Poplar borer

This illustration shows the irregular character of the galleries, the closed pupal cells with the coarse fibers stopping the free end, and the expanded character of the burrows about the exit.

PLATE 13

Saperda fayi

1 Gall in thorn branch, also holes made by woodpeckers searching for grubs

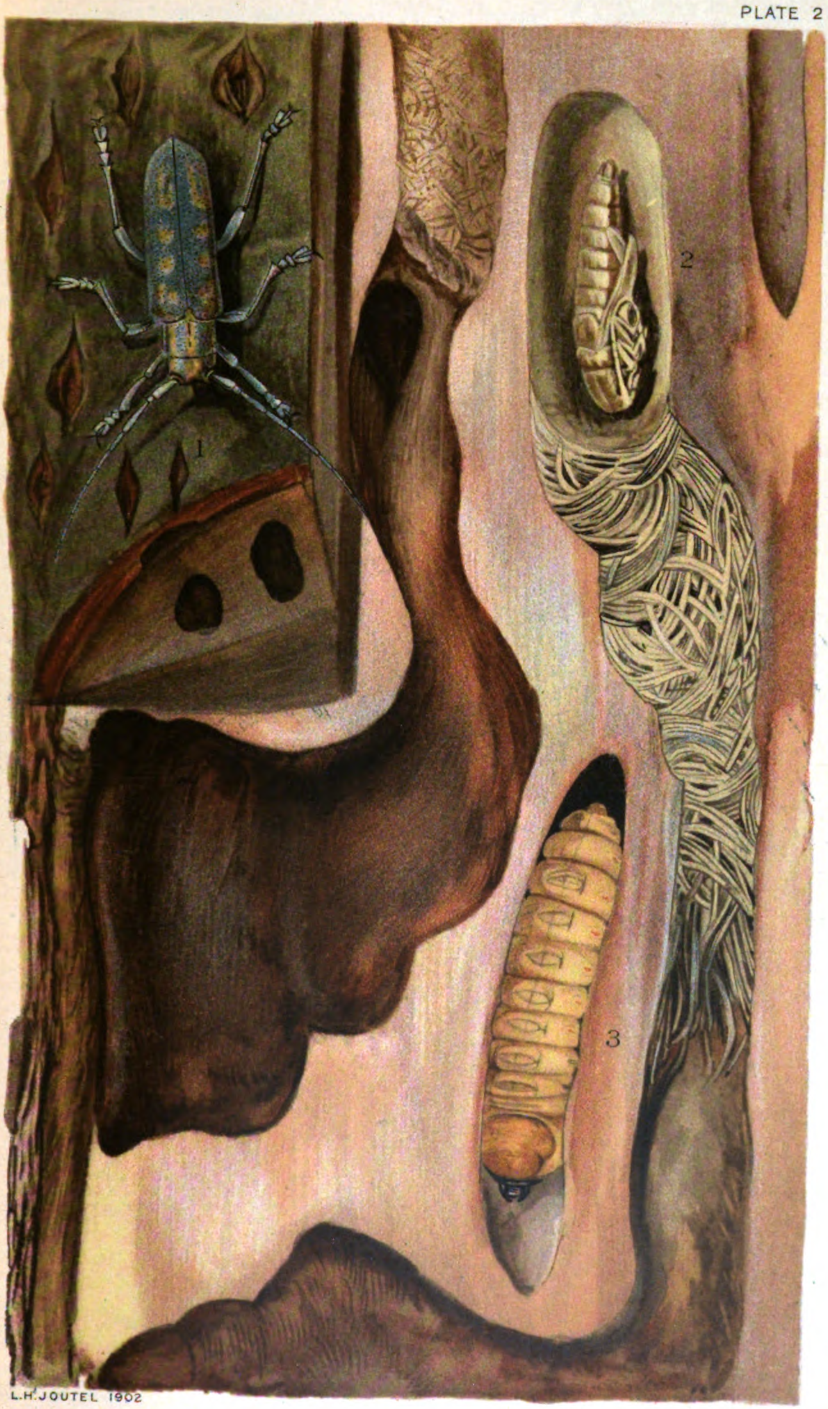
2 Typical, fully developed gall

PLATE 14

Holes of woodpeckers in alder, made in search of the larvae of Saperda obliqua

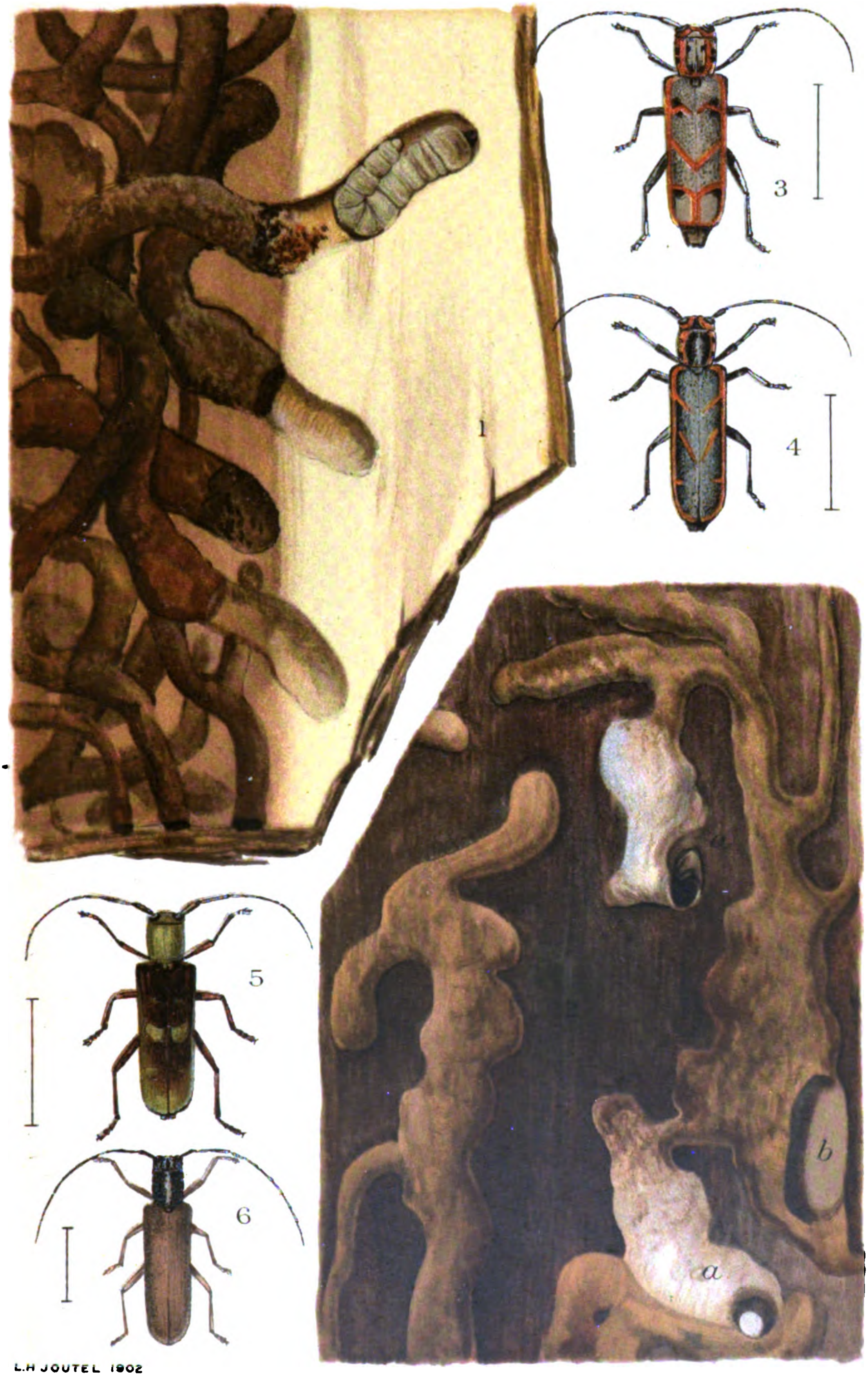
Saperda candida, appletree borer

PLATE 2



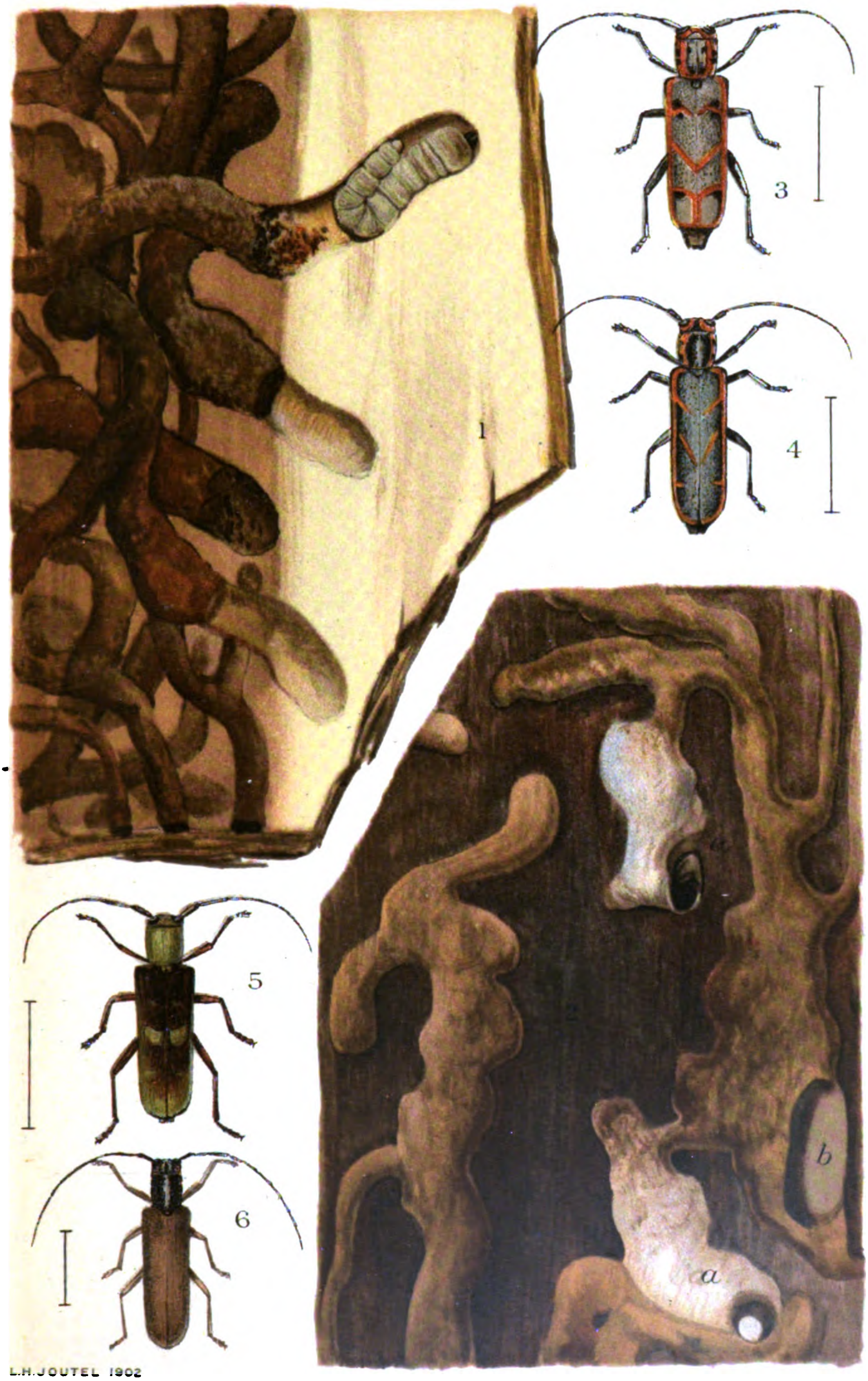
L.H. JOUTEL 1902

Saperda calcarata, poplar borer

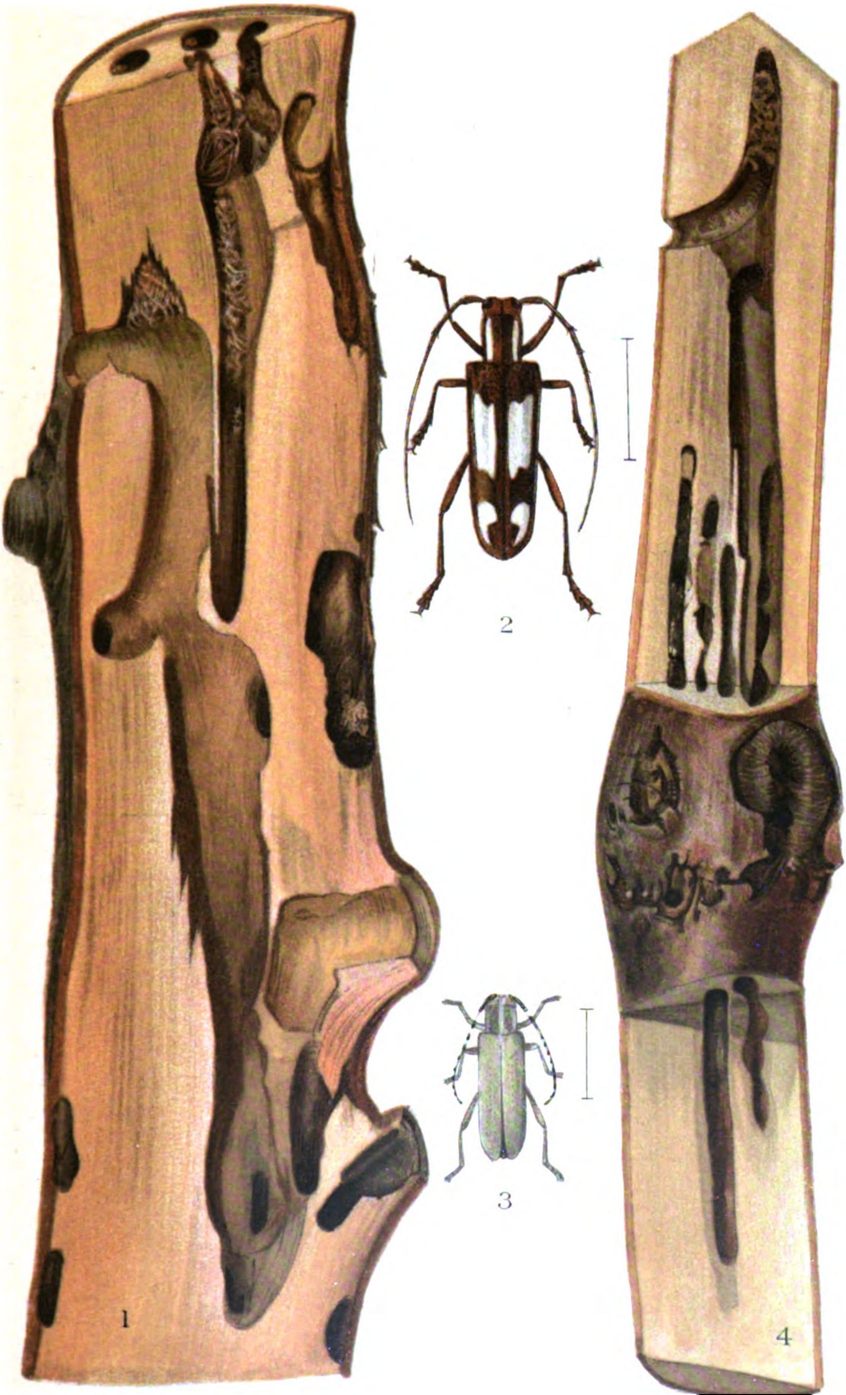


Saperda tridentata, imitans and discoidea
Elm and hickory borers

PLATE 3

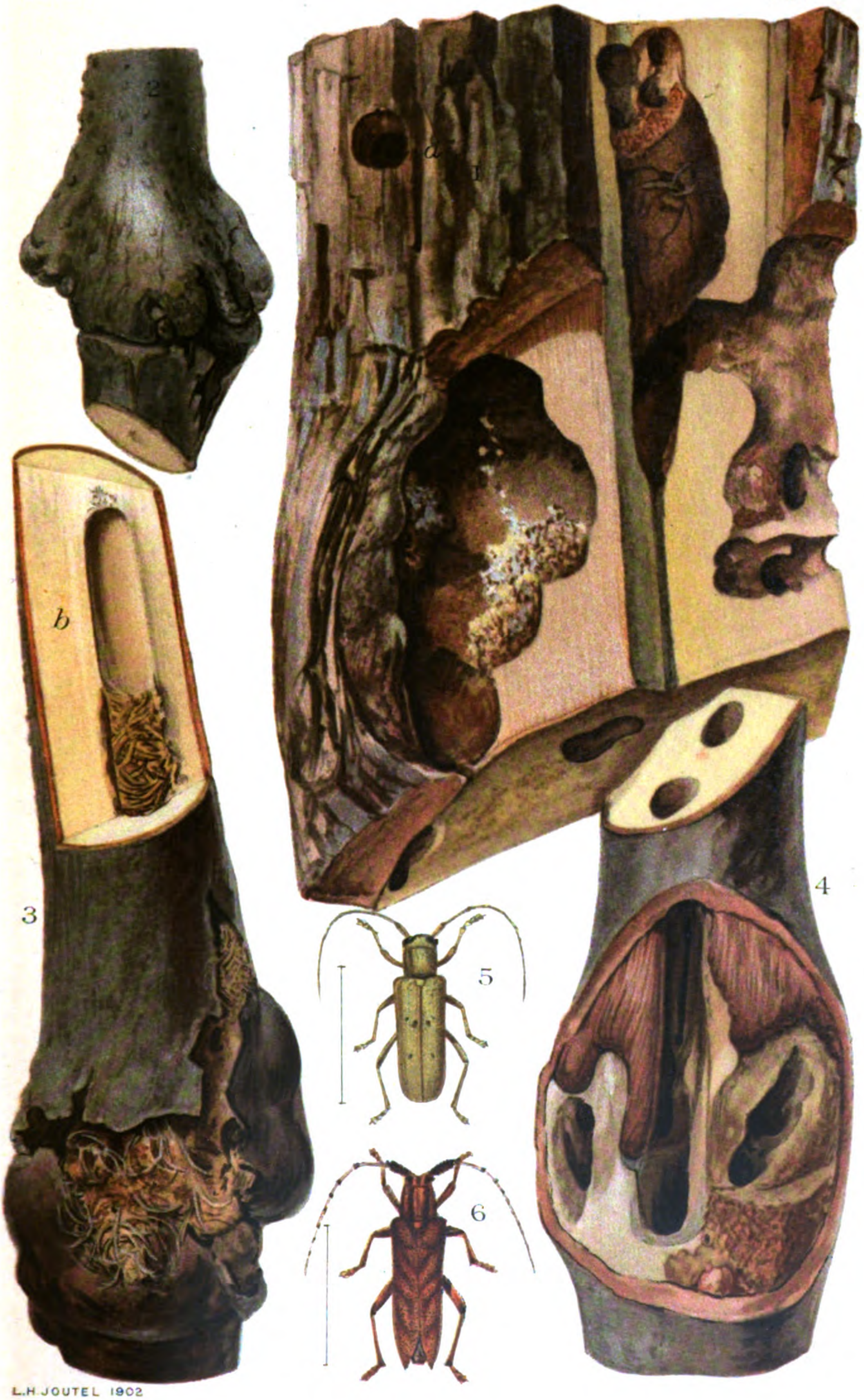


Saperda tridentata, imitans and discoidea
Elm and hickory borers



L.H JOUTEL 1902

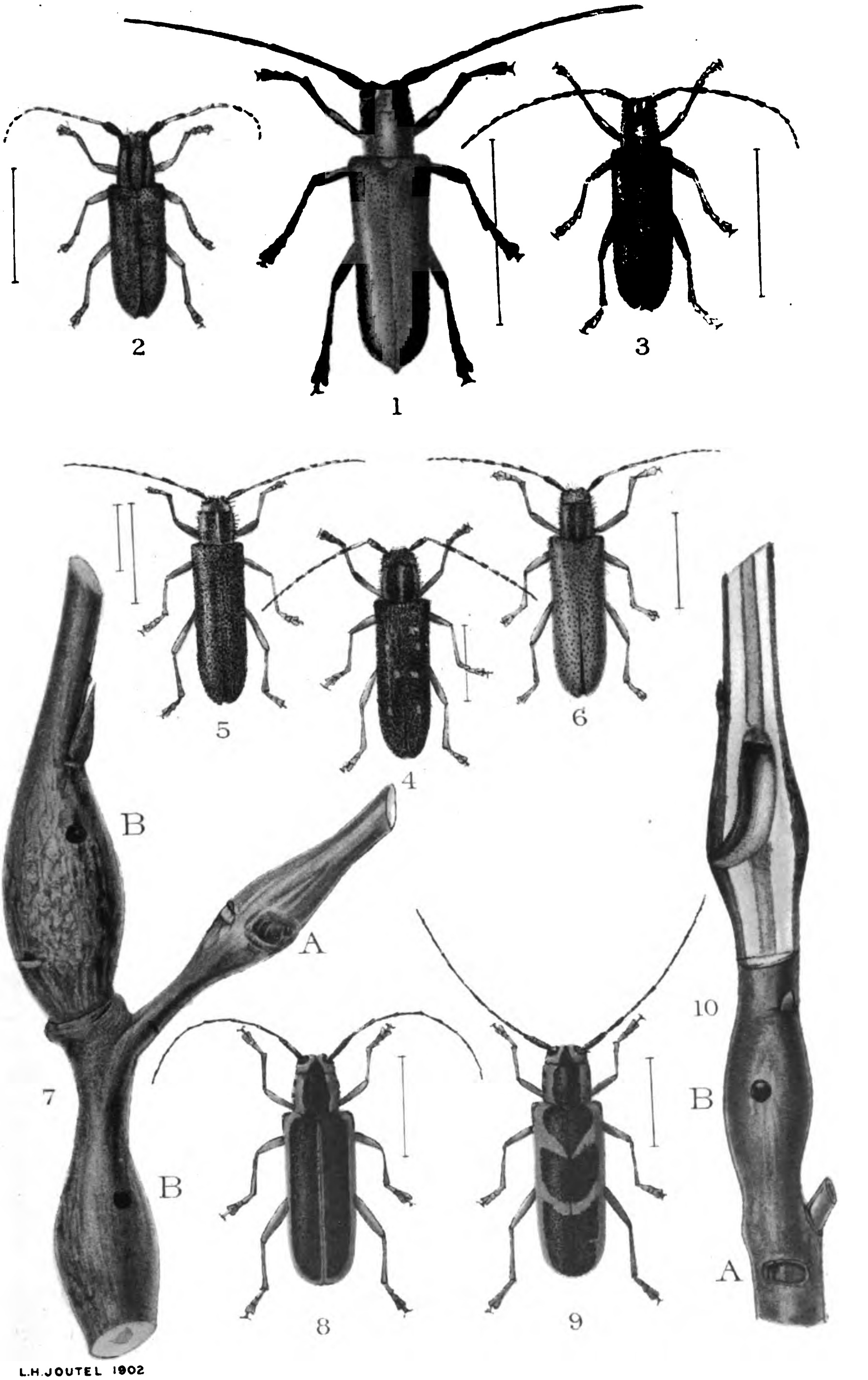
Saperda cretata and concolor
Spotted appletree and willow borers



Saperda vestita and obliqua
Linden and alder borers

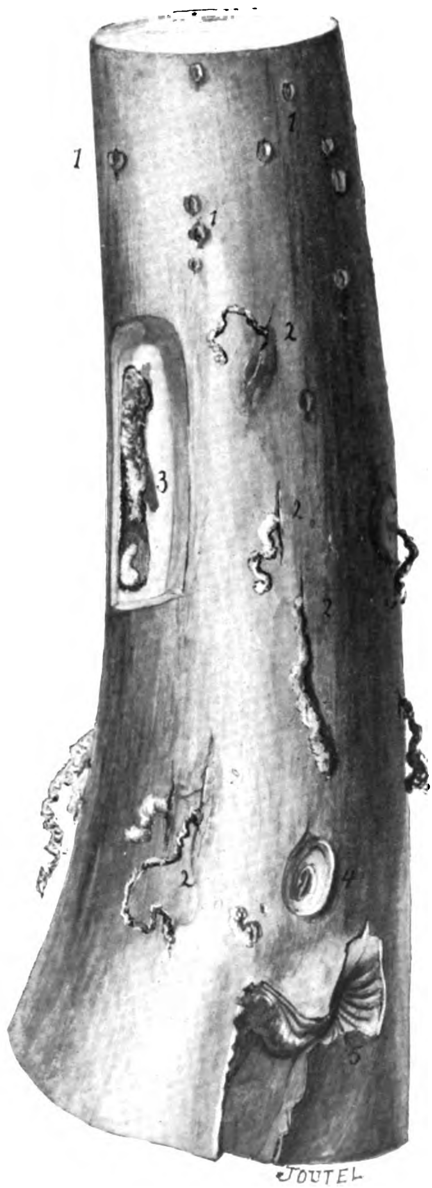
L.H JOUTEL 1902

Saperda fayi, puncticollis and concolor
Thorn, virginia creeper and willow borers



Saperdas

Plate 8



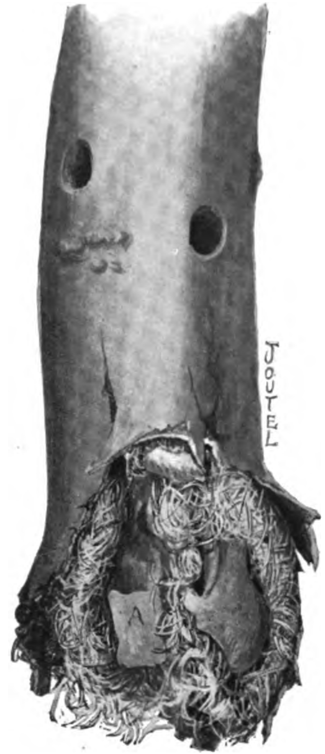
Early work of Saperda candida, appletree borer

Plate 9

Advanced work of Saperda candida, appletree borer

Plate 10

1

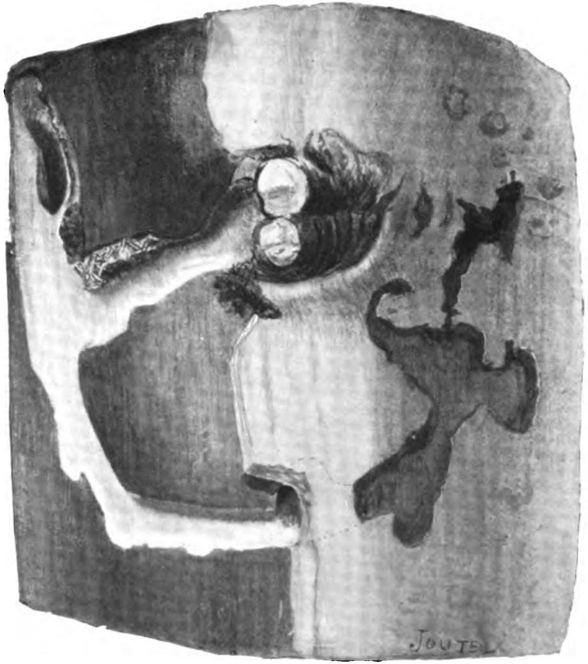


2

3

Advanced work of *Saperda candida*, appletree borer, at base of young trees

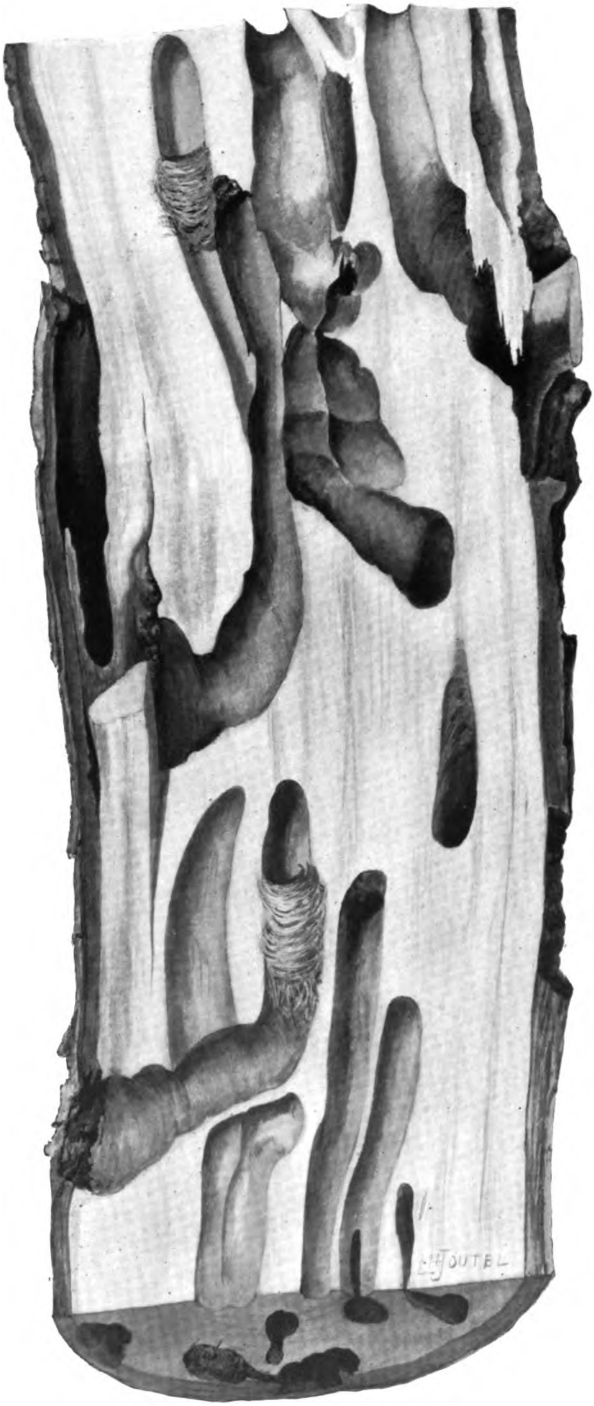
Plate 11



1

2

1 Early work of *Saperda calcarata*, popular borer; 2 Advanced work of *Saperda tridentata*, elm borer



Advanced work of Saperda calcarata, poplar borer

Plate 13

2

1

Woodpecker work and galls of *Saperda fayi*, in thorn

Plate 14

Woodpecker work in alder stem bored by *Saperda obliqua*

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New York State Museum

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